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ISSUED QUARTERLY

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CHAPEL HILL, N. C., U. S. A.

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Elisha Mitchell Scientific Society

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PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING OF THE NORTH CAROLINA ACADEMY OF SCIENCE HELD AT WAKE FOREST COLLEGE, WAKE FOREST, N. C., FRIDAY AND SATURDAY, APRIL 30-MAY 1, 1915

The Academy was called to order by President J. J. Wolfe at 2:50 P. M., with 21 members and 10 visitors present. Reading of papers was begun and continued until 9 had been read and discussed. President Wolfe then announced the following committees: Nominations, C. Cobb, F. Sherman, Jr., J. F. Lanneau; Auditing, A. S. Wheeler, B. Cunningham, C. S. Brimley; Resolutions, W. A. Withers, A. H. Patterson, Z. P. Metcalf. The Academy then adjourned at 5:30.

The Executive Committee—President Wolfe, Vice-President Patterson, Secretary Gudger, *ex officio,* and Prof. W. A. Withers—held its annual meeting immediately after adjournment. The following applicants for membership were unanimously elected:

1. F. E. Carruth, Assistant in Chemistry, N. C. Experiment Station, West Raleigh.
2. R. H. Field, Assistant in Zoology and Entomology, State Agricultural and Mechanical College, West Raleigh.
3. S. W. Geiser, Professor of Biology, Guilford College.
4. T. F. Hickerson, Professor of Civil Engineering, University of North Carolina.

5. R. W. Leiby, Assistant Entomologist, State Department of Agriculture, Raleigh.

6. Mary Lyon, Professor of Science, Southern Presbyterian College, Red Springs.

7. E. T. Miller, Professor of Engineering, Trinity College.

8. J. K. Plummer, Soil Chemist, State Department of Agriculture, Raleigh.

9. Elizabeth B. Potwine, Instructor in Mathematics, State Normal College, Greensboro.

10. H. Spencer, Assistant in Zoology and Entomology, State Agricultural and Mechanical College, West Raleigh.

A letter from the Secretary of the Faculty of the A. & M. College was then read inviting the Academy to hold its next annual meeting at that institution in 1916. On motion the invitation was unanimously accepted. The Secretary then gave his report as to (1) membership, (2) finances, and (3) the matter of raising the dues. These matters were discussed at some length and recommended to the careful consideration of the Academy at its annual business meeting. The Committee then adjourned.

At 8 P. M. the Academy met in evening session in Wingate Memorial Hall. After a cordial welcome to Wake Forest College delivered by Dean Charles E. Brewer, President J. J. Wolfe delivered his presidential address, "The Status of the Theory of Descent." Next Prof. John F. Lanneau delivered a lecture on "The Cosmoid" with a demonstration of an apparatus of his own design. Following him Prof. A. H. Patterson gave a demonstration and explanation of the working of a new form of humidifier of North Carolina make. His title was "The Importance of Humidity in Health and the Arts."

At 9:20 Saturday morning the Academy convened in annual business meeting with 19 members present. The minutes of last meeting were read and approved and the report of the Executive Committee as to the election of new members and the choice of the next place of meeting was had. Notice was ordered to be entered in the Proceedings of the

invitation to the recent inauguration of Prof. E. K. Graham as president of the University of North Carolina, and of our representation there by President Wolfe. The Secretary then made his annual report as to membership; that on January 1, 1914, there were 78 members, and that during the year there were 4 new members elected and 13 dropped because of removal from the State, non-payment of dues, etc., leaving 69 members in good standing on January 1, 1915.

The Treasurer then read his itemized financial statements as follows:

REPORT OF E. W. GUDGER, TREASURER, 1914-1915.
APRIL 23, 1915

RECEIPTS	
Balance last audit	$ 186.06
Dues since last audit	67.00
Interest Savings Bank	4.46
Total Receipts	257.52
Less Expenses	96.55
Balance	160.97
RESOURCES	
Savings Bank Balance	$ 114.47
Checking Bank balance	46.50
Total	160.97
Dues unpaid (about)	25.00
Stamped envelopes (about)	7.00
Estimated Resources	192.97
Estimated Debts	95.00
Estimated Balance	97.97
EXPENSES	
Proceedings, 1914	$ 75.00
Secretary's expenses, Durham	4.90
Postage	5.50
Typewriting and clerical help	2.40
Printing	8.75
Total Expenses	96.55

OUTSTANDING DEBTS

Proceedings, 1915	$ 75.00
Printing	5.00
Miscellaneous (about)	15.00
Total (about)	95.00

The Treasurer next drew attention to a comparative financial statement synopsized on the blackboard showing the receipts, expenditures, and balances since 1907-08, and making it clear that our yearly receipts do not meet our yearly expenses, and that the deficit has had to be met annually out of our gradually diminishing savings bank account. Considerable discussion was then entered into on the question of raising the dues. This course, however, was deemed unwise and it was thought best to institute a vigorous campaign for new members that the income from initiation fees might swell the cash receipts at the same time that new blood was infused into the Academy.

On motion, unanimously adopted, the President was empowered to appoint a committee composed of one or more members representing each locality where meetings are held, with two members for the State at large, whose duty it shall be to make every effort possible to increase the membership of the Academy. President Wolfe announced as the Committee for 1916: Chapel Hill, A. H. Patterson; Durham, E. T. Miller; Greensboro, Miss Gertrude Mendenhall; Guilford College, John S. Downing; Raleigh, C. S. Brimley and Z. P. Metcalf; Wake Forest College, John F. Lanneau; State at large, Franklin Sherman, Jr., and the Secretary, *ex officio*.

Reports of committees being next in order, the auditing committee reported the Treasurer's books, accounts and yearly statement to be correct. The nominating committee next reported and the following officers were elected for 1915-16:

President, A. S. Wheeler, Professor of Chemistry, University of North Carolina.

Vice-President, W. A. Withers, Professor of Chemistry, State Agricultural and Mechanical College.

Secretary-Treasurer, E. W. Gudger, Professor of Biology, State Normal College.

Additional Members Executive Committee: Z. P. Metcalf, Professor of Zoology and Entomology, State Agricultural and Mechanical College.

W. C. Coker, Professor of Botany, University of North Carolina.

E. T. Miller, Professor of Engineering, Trinity College.

The resolution committee presented the following report:

The North Carolina Academy of Science, assembled for its fourteenth annual session, finds itself under renewed obligations to President Poteat, Dean Brewer, and the Faculty of Wake Forest College for the considerate manner in which they have provided us with a meeting place, and the kindly and gracious manner in which the citizens of Wake Forest have entertained us in their homes.

The Academy feels itself the richer for having heard the scholarly address of President Wolfe, and the Academy, which already owes a great debt to its Secretary-Treasurer for the able manner in which he has conducted his office, feels itself again with greatly increased obligations on its hands.

Therefore be it resolved by the North Carolina Academy of Science, that President Poteat, Dean Brewer, the Faculty of Wake Forest College, the citizens of Wake Forest, President Wolfe and Secretary Gudger have combined to make this one of the most profitable meetings of this Academy.

The report of the legislative committee on ventilation was then called for and the committee then discharged from further duty.

At 10 o'clock the reading and discussion of papers was then resumed with some 25 members and visitors present. The session continued until all had been read when adjournment was had at 1:20 P. M. Of the 23 papers on the program only three were read by title.

The membership of the Academy at the present time is as follows (those present at this meeting being indicated by a *):

Allen, W. M.; Balcomb, E. E.; *Brimley, C. S.; Brimley, H. H.; Bruner, S. C.; Cain, William; *Carruth, F. E.; Clapp, S. C.; *Cobb, Collier; Cobb, Wm. B.; Coker, W. C.; Collett, R. W.; *Cunningham, Bert; Dixon, A. A.; Downing, J. S.; Edwards, C. W.; *Farmer, C. M.; *Field, R. H.; Fulton, H. R.; Geiser, S. W.; *George, W. C.; Gove, Anna M.; *Gudger, E. W.; Hammel, W. C. A.; Harding, W. T.; Herty, C. H.; *Hickerson, T. F.; Hobbs, A. Wilson; Hoffman, S. W.; Holmes, J. S.; Hutt, W. N.; Ives, J. D.; Kilgore, B. W.; *Lanneau, J. F.; Lay, George W.; *Leiby, R. W.; Lewis, R. H.; Lyon, Mary; McIver, Mrs. Chas. D.; MacNider, W. deB.; MacNider, G. M.; Markham, C. B.; Mendenhall, Gertrude, W.; *Metcalf, Z. P.; *Miller, E. T.; Mills, J. E.; Newman, C. L.; *Patterson, A. H.; Pegram, W. H.; *Plummer, J. K.; *Poteat, W. L.; Potwine, Elizabeth B.; Pratt, J. H.; Ragsdale, Virginia; Randolph, E. Oscar; Rankin, W. S.; Robinson, Mary; *Sherman, Franklin, Jr.; Shore, C. A.; Smith, J. E.; *Spencer, H.; Stiles, C. W.; Strong, Cora; *Totten, Henry R.; Venable, F. P.; *Wheeler, A. S.; Williams, L. F.; Wilson, H. V.; Wilson, R. N.; *Withers, W. A.; *Wolfe, J. J.

The following papers were presented:

DESMOTROPY

ALVIN S. WHEELER

The first case of keto-enol isomerism among the phenols of the naphthalene series was recently reported by Willsaetter and Wheeler. Juglone, a dyestuff in greenwalnut shells, yields on reduction 1, 4, 8-trihydroxynaphthalene, melting at 152°. After once being melted, it melts thereafter at 96°. Since this type of compounds is very sensitive to alkalies, weakly basic reagents as semicarbazine and phenylsemicarbazine were employed to detect the carbonyl group. The lower melting product was found to be the ketonic form. Some work, not yet published, on 1, 4, 5, 6-tetrahydroxynaphthalene reveals another case of this nature. Here however it has been impossible to separate the two forms, the compound melting at 154° responding readily to both enolic and ketonic reactions. Numerous isomerisation methods fail to reveal another form. The application of Knorr's ferric chloride method and Kurt Meyer's bromine method to approximate the relative amounts of the isomers present is not practicable to the above cases. Ferric chloride oxidizes the compounds to quinones while bromine enters the ring of either form.

THE H-H WATERWHEEL AND PUMP FOR FARM WATERWORKS

T. F. HICKERSON

The Hutchison-Hickerson Waterwheel and Pump, recently invented by R. B. Hutchison of Wilkinsburg, Pa., and T. F. Hickerson of Chapel Hill, N. C., is a discovery of a new application of the old principle of the overshot wheel in the design of a small easy running combination Wheel and Pump and Stand (made in the factory complete for installation) to utilize the flow and fall of small brooks as power for operating continuously a pump which pushes pure spring water to higher elevations.

The remarkable simplicity, adaptability, and reliability of this machine brings it in direct competition with Hydraulic Rams, all of whose defects seem to be met satisfactorily by the Wheel and Pump.

One dozen of these Wheels and Pumps have been introduced in North Carolina during the past year. Among these is one which delivers every day through a vertical height of 45 feet 500 gallons of spring water for a large farm home, where the power of the stream which operates the wheel is only 1-100 of a horse power.

ON LEIDY'S OURAMOEBA AND ITS OCCURRENCE AT GREENSBORO, N. C.

E. W. GUDGER

In the fall of 1914, considerable numbers of large and active Ouramœbas were found at Greensboro. The Amœbas themselves and the locality in which they were found were described. Their activities both in feeding and moving were discussed, and it was noted that there was no reversal of polarity, the tail-feather-like mass of fungous hyphæ always remaining posterior. The history of this interesting organism was then reviewed, and the conclusion arrived at that Ouramœba (tailed Amœba) is nothing but an ordinary Amœba which has ingested fungous spores which have germinated and formed a mass of mould hyphæ which projects from the posterior end of the animal. The full paper will be published shortly.

SOME IGNEOUS ROCKS OF MOUNT COLLIER

JOHN E. SMITH

Mount Collier is in Orange County, N. C.; about 5 miles west of Chapel Hill. It is typical of those igneous monadnocks of the eastern Piedmont, most of which rise to a common level about 200 feet above the peneplain. It was formerly much higher and of greater extent this is shown by the position of parts of the mountain that have been

separated from it by erosion, also by the fact that Ball Mountain, in Davidson and Rowan counties, of similar rock and structure has been cut by a river (Yadkin) which flows through it. That the upland level of the region is a peneplain is also proved by the presence of smooth, rounded quartz pebbles on this plain.

The mountain consists chiefly of dark rhyolite which made its way upward along the contact between the ancient crystalline schists north of it and the granite on the south. On each if its slopes flow structure has been observed in the weathered rock and in many places where it is fresh.

It is called Mount Collier in honor of Professor Collier Cobb who, in 1892, was the first to recognize its igneous origin. (Specimens and structure sections were used in presenting the paper.)

SOME OBSERVATIONS ON THE RED CEDAR

H. R. TOTTEN

Juniperus virginiana is our common cedar and is the only species of *Juniperus* that is at all abundant in North Carolina. *Juniperus communis,* the northern cedar, is known to occur in a few localities in the mountains. The male and female flowers of *Juniperus virginiana* are borne on separate trees. The time of flowering is dependent upon the climate and weather. The male trees begin blooming first and the return of cold weather may delay the female trees. In both the seasons 1914 and 1915 the male trees began blooming nearly six weeks before the female trees. The young "berry" is formed soon after pollination by the growth and fusion of the sporophylls about the ovule. Fertilization takes place about the middle of June. The seeds are matured in the first season. The species is very variable in color and habit of growth, varying in the neighborhood of Chapel Hill and Durham, in color from a glaucous to a deep green, and in form from an open spreading tree to a close spreading tree and to a narrow columnar tree.

SIGNIFICANCE OF GOSSYPOL IN THE COTTON PLANT

F. E. CARRUTH

Gossypol, $C_{18}H_{14}O_4$ (or possibly $C_{32}H_{34}O_{10}$) according to Marchlewski* appears to be a dihydric (ortho) phenol.

It occurs in peculiar glands, "resin glands," in all parts of the cotton plant. Its physiological significance is not clear. The change in color of the cotton flower on ageing is probably due to it.

It is a yellow substance, dissolving in H_2SO_4 with a red color and oxidizing easily in alkaline solution with a deep blue color. It is being studied in an endeavor to show that it is a respiration pigment

* J. Prakt. Chem. 1899, 60, p. 80.

or an anthocyanic substance, rather than an end-product of plant metabolism. An effort to elucidate its constitution is being made by the N. C. Experiment Station.

FLY-PARASITES AS A FACTOR IN CONTROLLING ARMY-WORM IN NORTH CAROLINA IN 1914

F. SHERMAN

The Army-worm (*Heliophila unipuncta*) was destructive in many localities in North Carolina in 1914, attacking millet, grasses and grains. Tachina-flies were abundant and laid eggs on the worms.

A lot of 534 army-worms was separated into groups according to number of eggs per worm, and rearings made. Worms without visible eggs matured less than 10 per cent of moths. Of worms with fly-eggs less than 1 per cent matured moths.

Highest development of flies was from worms with 3 parasitic eggs each (32.81 per cent), the rate consistently declining both below and above that point.

On all worms collected, the average was 2.44 fly-eggs per worm, close to the desired optimum. Outbreaks were of short duration and there was no widespread damage by any later broods.

A more detailed article covering this work will be found in Journal of Economic Entomology for April, 1915.

ON THE MYTH OF THE SHIP-HOLDER, THE ECHENEIS OR REMORA

E. W. GUDGER

A brief account was given of some of the data relating to this myth, which began about the time of Pliny the Elder and persisted until about 1660. The true explanation was given by Ekman in 1904 in his work on "dead water."

Material and data are being collected for a series of papers giving accounts of and explaining the myth, describing the use of the Remora as a living fish hook, and lastly giving as fully as possible the natural history of the fish—the matter of chief interest being the origin of the sucking disk.

THE SEXUALITY OF THE FILAMENT OF SPIROGYRA

BERT CUNNINGHAM

The general opinion as shown by Wood (1872), Wolle (1887), DeToni, Klebs (1896), Vines, Bennett and Murry, and Mottier (1904), is that the filaments contain cells of one sex. West (1904), basing his assertion upon Hassall (1845), states that cross conjugation is exceedingly rare in Conjugales.

The writer found a Spirogyra which follows the general description of Quadrata, with the exception of reproduction. This frequently occured as cross conjugation, the zygotes being in such a position that it could not possibly be a combination of lateral and scalariform conjugation.

This occurrence would tend to prove that the filaments of some Spirogyra at least are truly bisexual, and that the transition from the bisexual to the unisexual occurred in the family of Spirogyra.

ABNORMAL SPECIMENS OF TARAXACUM

S. W. GEISER

This paper notes the occurrence of a clump of dandelions at a point 70 feet e. n. e. of the n. e. corner of Cox Hall, on the Campus of Guilford College. Seven specimens showed well fasciation of the flower-stipes. The multiple-headed character was not so pronounced as noted by *Kirsch* (1909:) only two or three stipes in each of the specimens were united. The flower heads were either slightly confluent or independent. At the point of collection, the soil was unusually infertile, and the occurrence suggests *Nieuwland's* ('09) conclusion that the abnormality is due to a physiological change due to unfavorable soil conditions, and to age. *Bowditch* ('09) has also noted fasciation of the dandelion (*T. off.*) in an unfavorable environment. Diligent search failed to find abnormal specimens outside of the local circumscribed area.

For the following papers no abstracts have been received.

The Present Status of the Martian Controversy—A. H. Patterson.

Filose Phenomena in Pieces of Gonads of a Cubomedusa—H. V. Wilson.

More Fossil Plants from the Moncure Shales (32 specimens)—Collier Cbob.

Cow Pea Weevil—Z. P. Metcalf.

Gossypol, the Toxic Substance of Cottonseed Meal—W. A. Withers and F. E. Carruth.

The Influence of Salt Solution on the Development of the Frog Egg—W. C. George.

Experimental Alteration in the Direction of Growth of a Sponge—H. V. Wilson.

The Importance of Humidity in Health and the Arts (with demonstration of a new form of Humidifier of North Carolina make)—A. H. Patterson.

Simplifying our Methods of Teaching Cell Division—Z. P. Metcalf.

Monadnocks and Metamorphism in the Cretaceous Peneplain—Collier Cobb.

The Origin of the do, re, mi Syllables for the Musical Scale.—A. H. Patterson.

Notes of Geology of Smith's Island—Collier Cobb.

E. W. Gudger, *Secretary.*

AN OUTLINE OF MODERN WORK BEARING ON THE THEORY OF DESCENT

BY J. J. WOLFE

In my eagerness to select a subject worthy of presentation on this occasion, I have, like many another, attempted a task much bigger than I had realized. It is apparent that nothing approaching encyclopædic treatment is possible. You will, therefore, find much important work conspicuous by its absence. I do, however, regard the generalizations and experiments discussed as being, in the main, those most pertinent to the matter in hand.

You can hardly be better persuaded than I am, that it is hazardous in the extreme to attempt to speak at the present time with any degree of positiveness concerning the subsidiary theories involved. Wide differences exist in the minds of equally able students both as to the value and the interpretation to be put upon recent and current work. The subject, however, is so vital, and so grips the attention wherever we meet it, that it seems to me well worth while to review this work even if it must be in a most tentative fashion.

MENDEL'S LAW

We may begin this review with the opening of the present century. Until this time the theory of descent was in its essentials just as Darwin had left it in 1859. The year 1900, however, is made memorable by the rediscovery of the unpretentious studies of an Austrian monk, Johann Gregor Mendel. His results were published in 1866 in an obscure journal where they lay buried until unearthed independently and almost simultaneously by three distinguished botanists, Dr. Vries of Holland, Tschermak of Austria and Correns of Germany. Mendel was a student of Carl Nageli, another great botanist, to whom he sent his results, but somehow the master failed to grasp the significance of his old pupil's work.

Mendel's method differed from that of earlier students of heredity in that he focused his attention upon the behavior of a *single* pair of alternative characters. He selected the ordinary garden pea to work with, and for eight years carried on his experiments in hybridization. The parental characters reappear in their hybrid offspring in a perfectly definite fashion, which has come to be known as "Mendel's Law."

An example or two may make this clear. A tall pea, crossed with a dwarf, produces offspring which are invariably tall. So it is when round seeded pears are crossed with wrinkled ones, yellow with green and with a host of other character-pairs which have been tested by Mendel and his followers. The offspring are not intermediate in character between the two parents as had been universally supposed to be the case, but wholly like one parent which Mendel called the dominant. The character which does not appear in the offspring—dwarfness in this case—is called recessive.

Now when these hybrids are interbred, three kinds of offspring are produced and, when the numbers are large, in fairly definite proportions. One fourth are dwarfs and breed true. The remaining three-fourths are tall, and look alike, but behave differently in reproduction. One of the fourths is tall and breeds true, the other two-fourths are tall, but not true breeding—they split up again in the same ratio —25 per cent true breeding tall, 25 per cent true breeding dwarfs, and 50 per cent tall but not breeding true, and repeating this behavior in the next generation.

Another case—the blue Andalusian fowl does not breed true. Its offspring is 25 per cent white, 25 per cent black and 50 per cent blue. The whites and the blacks breed true to color, but the blues repeat the story. The Andalusian is thus seen to be not a true race of fowls but merely a hybrid between a white and a black race, in which black is not entirely dominant as it is in guinea pigs for example, and as it usually is, and as tallness is to dwarfness in the case of garden peas.

Similar experiments have been carried out involving two and even three pairs of such characters, but the combinations become too complex for presentation without figures. Suffice it to say that with but few exceptions any pair of characters will behave as above described.

Cases such as those cited show that a character may be extracted in a pure state from a hybrid even when it is completely masked by a dominant. Characters must therefore be represented in the germ cells by independent units that never lose their identity.

Mendelism thus puts in the hands of the experimentalists a definite standard of measurements by means of which he may test the hereditary constitution of living organisms, and to the practical breeder its gives a definite formula in accordance with which he may purge a chosen race of undesirable characters and even supplant them with desirable ones extracted from many sources, with somewhat the same exactness that a chemist extracts and combines his chemicals.

THE PURE LINE

Before great progress can be made in any science, the fundamental units which enter into its facts must be clearly understood. "Chemistry was alchemy until the chemical elements were identified and isolated." Similar fundamental units in heredity are the Mendelian unit characters, and we now speak of heredity in terms of unit characters rather than of the individual as a whole.

A species as the term is today coming to be understood consists of subsidiary groups of individuals, which groups differ from each other in average size, structure, color and other unit characters, which in heredity, according to Jennings, behave "as rigid as iron." The progeny of individuals belonging to one such group constitutes the so-called "pure line." This conception rests upon the brilliant and independent investigations of the Danish botanist Johanssen, the American zoologist, Jennings, head of his department at the Johns Hopkins University, and the Swedish botanist Nilsson.

Johanssen, to cite the work of but one of them, experimenting with beans, isolated nineteen such groups of pure lines, " . . . . the progeny of each of these pure lines of beans varied around its own mean, which was different in each of the nineteen instances." It matters not whether the smallest or the largest individuals are chosen to breed from, the progeny in either case is the same, which is the average for the pure line in question. The conclusion then is that "Selection within a pure line is absolutely without effect in modifying a particular character in the offspring of the line in question." Nor can selection from the mixture of pure lines which constitute the species accomplish more. The utmost that it can do is to isolate that pure line which exhibits the character in question developed to the highest degree. Manifestly this is a discovery of far-reaching significance, for if these things be so, how can the transition from one pure line to another have been made? That such transitions have repeatedly occurred is, it would seem, beyond intelligent question, but how, looms larger today than ever before. There seem to be but two answers now made to this question: one of these is mutation, which makes the passage from one pure line to another at a single bound, but which seems to me much too questionable a support for any great super-structure; the other is the inheritance of acquired characters, an ancient dogma but not now in good standing in most approved scientific circles. Later on I shall discuss each of these theories at some length, but now before leaving this topic it should be added that Johanssen has recently reported mutations within his pure lines. This is, however, as Walter has pointed out, a clear case of the logician's "vicious circle." For so long as a variation does not reappear in the progeny it is taken to prove that such variations are individual, due to effects of the environment, and not heritable, but, whenever such variations do reappear, they are at once styled mutations.

DARWINISM

With your indulgence, I will now sketch in as briefly as

I may the background of Darwinism upon which mutation may be most effectively projected. Darwin, as you well know, based his theory of the origin of species upon the minute variations presented by all living things. There are no two human beings, no two trees, no two flowers, in fact no two living things of any kind exactly alike. Nevertheless, organisms continue to produce offspring which in the main resemble their parents. The developing plant or animal behaves as if it were acted upon by two opposing forces, one heredity, a centripetal force tending to hold it down to type, the other variation, a centrifugal force tending to throw it off at a tangent. These variations occur in all directions, some of advantage to their possessors, some possibly without effect, others positively detrimental.

Couple with this the further fact that vastly more plants and animals are produced than can possibly find room and food for development. It is difficult to conceive the prodigious members of every species that would exist were it not for checks put upon them by the environment. The conger-eel it is said lays 15,000,000 eggs. If these all reached maturity it has been computed that in less than ten years, the waters of the globe would be solidly full of conger-eels, all the progeny of a single pair. "Even slow-breeding man," says Darwin, "has doubled in 25 years." "At this rate in less than a thousand years there would literally not be standing room for his progeny." In the keen competition that must thus necessarily ensue in a state of nature the great majority of these are doomed to early destruction. Manifestly it is the best endowed, the fittest in Darwin's phrase who survive. For this process Darwin coined the term *natural selection* and looked upon it as the controlling principle in shaping the course of evolution. It operated on those minute variations already referred to, weeding out those individuals which did not vary in directions tending to adapt the organism more perfectly to its environment. The summation of these favorable variations in the course of time would be suffi-

cient to warrant classifying the form as a species distinct from the parent type.

From the flood of criticism that fell upon the "origin" two ideas may be singled out for consideration. First is the view that imperceptibly small variations in the direction of producing a new structure could be of no possible service and therefore would have no selection-value. Second, that geologic time is too short for the evolution of the complex living forms that we know out of simple undifferentiated organisms. Without entering into a discussion of these objections, suffice it to say that their weight was felt to be great by many Darwinians. To such, and many others, the mutation theory was most welcome.

MUTATION

It was ably presented to you at the Wake Forest meeting five years ago by President Poteat. I shall therefore at this time attempt only a brief outline. The mutation theory is the great life-work of Hugo De Vries of Holland already referred to in connection with the rediscovery of Mendel's results. Appearing in 1901 it embodied the extensive experimentation of the preceding twenty years. As a basis for the operation of natural selection, De Vries takes the more striking variations, the previously called "sports" to which he gave the name—mutants—such for example as the sudden appearance of a rose-comb in an apparently pure bred race of single comb fowls, or a white English sparrow, several times recently reported in "Science," and which I observed some months ago on the streets of Durham. Darwin was familiar with this phenomenon and cited numerous cases in his "Animals and Plants under Domestication," but after mature deliberation and after it had been urged upon him by some of his closest scientific friends, he reached the conclusion that "sports" were without important effect on the origin of species—an opinion it would now seem destined to receive recruits.

These sports or mutants breed true from the beginning and thus furnish a foundation for the view that new species

are produced, not as Darwin thought by the gradual accumulation of minute differences, but all at once by the sudden appearance of full fledged new characters which sharply distinguish them from the parent species.

The theory certainly leaped into favor. It effectively disposes of the criticisms of Darwin's theory to which I have referred. Furthermore, mutations instead of being extremely rare phenomena are almost becoming common. This is due it would seem to the fact that mutationists are coming to lay less emphasis upon the magnitude of a mutation and more upon its heritability. Many of the departures that now pass as mutations could I think very well be included under Darwin's variations. To claim heritability as a criterion between mutations and Darwinian variations as seems now to be the tendency would, in my judgment, rob Darwinism of all claim that it has to bring an explanation of evolution, since it leaves it in the absurd position of being based on non-heritable variations.

CRITICISM OF MUTATION

For some years now there has been a growing suspicion that the phenomena of mutation are really due to hybridization. The English geneticist, Bateson, seems to have been first to suggest that Lamarck's evening primrose, upon which De Vries primarily based his theory, is in reality a hybrid. Much evidence has now accumulated to sustain this view.

Davis, Professor of Botany at Pennsylvania, has attempted by hybridization to produce a complex type which in reproduction will behave like *Oenothera Lamarckiana*. He has apparently succeeded in producing fairly constant hybrid races which occasionally throw off mutants much as does the classic example. Similar results have likewise been obtained by Tower working with potato beetles.

But in my judgment the most significant attack upon mutation has been made by Jeffrey, of the Harvard Botanical laboratory. Jeffrey investigated the evening primroses with a view to determining the amount of sterility present. It has long been known that infertility was characteristic of

hybrids, and curiously enough this fact was invoked as long ago as 1837 in support of the view that the sperm was really essential to the act of fertilization. In that year R. Wagner showed that sperms were invariably absent in non-fertile hybrids and as invariably present in all fertile males. Jeffrey found that without exception a high degree of sterility was characteristic of every species examined. Furthermore all known hybrid plants available were examined with essentially the same result. On the other hand an extensive investigation, ranging from the highest to the lowest plants and including a large number of species as to whose genetic purity no suspicions are entertained, revealed absolutely no sterile pollen whatever. Since in this respect the evening primroses ally themselves with undoubted or suspected hybrids Jeffrey maintains that the group as a whole is much contaminated by hybridization and that no such important theory as mutation should rest upon so dubious a foundation. De Vries has recently replied at considerable length to Jeffrey's attack but without, in my judgment, seriously damaging the criticism.

Among other things, he cites cases of mutation in the common shepherd's purse and asserts that its pollen is all perfect. This, however, is manifestly an error. I have just begun an examination of this plant myself and there is abortive pollen here, just as Jeffrey found in all his hybrids.

Since the connection between sterility and hybridization has been so long and so well known, it would seem strange that its significance should have escaped De Vries, who was aware of the fact that sterility was more or less abundant in his primroses. In the controversy which is still going on, it appears that De Vries is inclined to admit the contention of Davis, Tower, Jeffrey and others that mutants may arise as a result of hybridization, but still clings, with other mutationists, to the view that mutation is a distinct phenomenon in no way dependent on hybridization.

To be sure there are numbers of cases where mutants or sports have appeared in which it is very difficult to impugn

the purity of the strain, nevertheless in the present state of our knowledge it would seem wiser to account for them as a result of hybridization far back in the line, than as the production of an entirely new character by the operation of some as yet wholly unknown force.

While this would seem to be true it is possible that it does not apply to all cases. De Vries divides his mutants into two classes, one characterized by the appearance of a character wholly new, and the other by the loss of some character previously possessed. This latter, it would seem, might and probably does occur with the intervention of hybridization. It is a matter of common knowledge that accidents happen during the embryonic history of the individual which prevent the development of organs and tissues and, to me at any rate, it is no more difficult to think that certain conditions might, even in the germ cells, destroy, some one of these units of living matter which would otherwise in the mature animal express itself as a character. For example, albinos are simply animals in which for some reason or other the color factor has failed to express itself. Granting this, however, the tendency of present investigation is to rob mutation of any really great significance in the hypothesis of descent and perhaps throw us back either to Darwin or Lamarck.

ACQUIRED CHARACTERS

Whether acquired characters are inherited or not constitutes for biologists a seemingly eternal question. Are diseases, mutilations, habits, the effects of use and disuse handed on to offspring—these are some of the forms in which the query has been put. But from whatever angle the problem be approached the real aim has been to find whether or not the environment can in any way reach and impress itself upon the germinal substance so that its effects may be transmitted. That such is the case was generally believed a hundred years ago and the idea was made the foundation of the theory of evolution propounded at that time by the celebrated French biologist Lamarck.

There are some more or less well known practices which incidentally seem to support this hypothesis—for example the growing of bacteria under adverse conditions such as excessive heat with a view to reducing their virulence. Certain disease-producing forms so treated may then be safely injected into the human being, whereas before such treatment it would have resulted fatally. Southern market gardeners pretty generally purchase northern grown seed where early crops are desired. The explanation is that short northern growing season somehow speeds up the life processes so that the cycle is complete before cold weather. Seed from plants so grown are supposed to inherit this rapid maturity.

Tower, a zoologist of Chicago University, in his experiments with potato beetles found that species carried from Chicago were so altered by a stay at Tucson, Arizona, under desert conditions that when carried back to Chicago some years later they were unable to withstand the winter. According to Tower no selection is practized and this condition is gradually brought about.

Bordage, a botanist of Reunion, a French island off the coast of Madagascar, reports that European peaches carried to Reunion retain their deciduous habit permanently at higher altitudes, but in the coastal region the leafless period is gradually shortened until after 20 years they are completely evergreen. Seedlings of such trees show the acquired character to the same extent as the parent tree, but no more. Furthermore they retain this character even to the second generation in higher altitudes where trees that have not been so modified shed their leaves every autumn.

Besides such cases there have been many experiments devised primarily to prove this proposition. Bonnier, a member of the French Academy of Sciences, published in 1895 an extensive series of experiments. In all he handled 105 species. Plants growing in the lowlands were transplanted to alpine conditions. In a few years these had acquired the aspect of the characteristic alpine species of the same genus even to cell and tissue structure. When carried back to the

lowlands, plants that had grown at elevated locations for four to six years retained their alpine characters for four to six years, but eventually returned to the habit and character of lowland types.

The well known German botanist, Klebs, likewise experimented extensively in this line with the net result that many acquired characters are inherited while others are not. Perhaps experiment should now be directed toward ascertaining just what acquired characters are inherited.

Lest you should imagine that I have ignored the evidence from the zoological side let me briefly refer to Kammerer's results. It should be added, however, that zoologists are more nearly a unit than botanists in the view that acquired characters are *not* inherited.

Kammerer at Vienna by reducing the amount of water succeeded in permanently modifying aquatic species of salamanders so that they came more nearly to resemble land forms and by changing the color of the soil on the bottom of the aquaria transformed the color of the animals so as to correspond very nearly with the color of the substratum. These effects according to Kammerer are hereditary. There are numerous other experiments of this kind made on animals with corresponding results, still it must be said that the bulk of the evidence furnished by experiments on animals seems to support the negative side of this proposition. Unfortunately, however, this is not a question that can be settled by majorities in the good old democratic way.

Castle, of the Harvard Zoological Department, as well as several others, has made some beautiful experiments in the hope of solving the problem. Their method consists in grafting the ovary of one animal into another from which her own had been removed. The body of the animal operated upon may be looked upon as a new environment for the engrafted ovary, and by reason of the intimate relations existing ought to exercise a marked influence in heredity, if such a thing be possible.

The details of one of these experiments is as follows:

The ovary is removed from a young female, white in color, and that from a black animal substituted. The animal operated upon is then mated with a male pure white in color. All the offspring were absolutely black. The black ovary although transplanted to a white animal produced young which were colored exactly the same as would have been the case had the ovary remained in the body of the black animal from which it was taken. This is in accord with Mendelian principles—black dominating white. In other words the body tissues of the foster-mother had no effect whatever, upon the color of the developing embryo. Castle, as well as others, has regarded such experiments as lending great support to the view that the environment produces no heritable effects. The lifework of August Weisman, the great German biologist and philosopher, who died last fall, was in a sense a continuous and formidable onslaught upon Lamarck's hypothesis. Weisman founded his attack upon the fact that the germ substance is very generally early set apart in the development of each animal from egg to adult. Once so set apart, he contended, the germ cells could not be influenced by the tissue cells, a thing must happen if a character impressed upon the body cells is to become hereditary. This has now become to be pretty generally the dominant view with geneticists and embryologists. The Weismannian contention, however, is not so formidable as it once seemed. It is a well known fact that the germ cells exercise a profound influence on the body cells. Is it too wild a flight to suppose that there might be a reverse influence? At any rate such a view becomes somewhat more tenable in the light of recent researches on the ductless glands, which have their effect in distant parts of the body by means of substances secreted into the blood. These substances are called harmones, and it is coming to believed that they are of very general occurrence and very great importance.

The fact upon which Weisman based his criticisms seems to me to furnish a basis for the more or less evident line of cleavage between zoologists and botanists on this question.

The germ-plasm is early set apart in animals, but this is not so in plants which develop new germ tissues each season. Also it would seem more difficult for the environmental influences to penetrate the thicker envelope of body tissues in animals,and to produce effects upon cells in more or less constant environment. The body fluids surrounding these cells and which constitute their environment are artificially maintained at fairly uniform pressure, temperature, composition, and concentration. For these reasons it would seem to be much easier for environmental factors such as temperature, moisture, and light, to act upon the germ tissues of plants than of animals. However this may be, it is much more than probable that any generalization such as the inheritance of acquired characters if found to be true for plants would also be true for animals, although it is easily conceivable that special animal characteristics might render the operation more difficult of observation.

Such a view appears at least to be near the truth. The inheritance of environmental effects in some fashion has long seemed to me a logical necessity. To assume that they are not, would force the conclusion that *all* heritable variations are represented in the germ-plasm, and, to carry the thing to its ultimate end, there were bundled up in the first organism all the infinity of possibilities that have since appeared in living things. Darwin, in his later writings, felt that the environment in some way acted upon the germ cells so as to call forth variation, but the cause of most variation was so dark that he frequently referred to its as spontaneous. I take it, however, that at the present time no scientific man will undertake to maintain spontaneity of any kind and by the word merely means that the cause is unknown.

Therefore, so far as I can see, we are shut up to one or the other of these conclusions, either new characters, which can be transmitted and summed up in heredity, are called forth by the environment, or all past, present, and future variations were present in that primordial germ cell and subsequent variation has been a process of release by the drop-

ping out of something which inhibited the appearance of these characters so long as it was present. This is just the view proposed by William Bateson in his presidential address to the British Association for the Advancement of Science last summer at its meeting in Australia.

Certainly this is not a very satisfying theory, still it is not altogether unthinkable as the philosophers have a fondness for saying. At any rate we have at least one striking analogy —the mature man develops from a fertilized egg so small that it is scarcely visible to the unaided eye; nevertheless, there are collected within this small scope representive units, which we call determiners, for every important physical, mental and moral trait that constitutes the fully developed man.

CONCLUSION

The hypothesis of descent is thus in a somewhat unsatisfactory state. The newer researches have made old views untenable without in themselves furnishing a complete explanation. Such periods, however, are not infrequent in the history of science. At the present time, there is little that can be asserted with any degree of positiveness beyond the fact that somehow or other evolution has occurred. This central fact has been strengthened with the passage of the years, although as regards just what has taken place, how, and by what means, they have left us pretty much as we were in 1859 after the appearance of Darwin's "Origin."

These years of research have been wonderfully effective in untangling the factors in a most complex problem and the reason why success has not been completely attained seems to me to lie principally in the fact that the problem was more complex than the workers have, hitherto, realized. With the experimental method added to the equipment of the investigator, which, in my judgment has been hitherto limited too much to the microscope, and with the concise results of Mendelism, mutation and pure line investigation, it seems to me not extravagant to expect a comprehensive explanation of the problem at a date not very far distant.

And now, before I conclude, let me add that it with much pride that I note the brilliant part taken by Americans in this line of investigation, and that, if the past be any guarantee of the future, I predict they will have a far greater share in its final solution.

And also, in conclusion, perhaps I should explain that, if in the rather frequent use of the first person it seem to you I have attached undue importance to my own views, this form of expression has been often assumed for the sake of brevity, but more especially to indicate that an opinion was being expressed which could not be said to have won its way to anything like an universal acceptance.

DURHAM, N. C.

RADIO-ACTIVITY AND THE PERIODIC SYSTEM*

The periodic system of the elements has for nearly half a century proved a most puzzling and absorbing problem to chemists. It has been called a law, but while there is undoubtedly an underlying law or laws, I doubt whether we have as yet any very clear conception of them. Certainly, the usual statement that the properties of the elements are periodic functions of their atomic weights was never strictly true, even in days of partial knowledge, and is much less true now. It was neither the periodicity "of the geometers," as Mendeleeff himself said, nor the function of the mathematician. Indeed, we have now come to a view where, apparently, we must abandon the atomic weight as the only or even the chief determining variable.

The truth is that for many years after its announcement it was more truly a working hypothesis, and a great deal of work had to be and still has to be done before it can attain to its completed form. It contains much that is true, has been most useful as a guiding principle, and has shown a wonderful power of adjustment to new facts and increasing knowledge.

It was in 1895 that the system had to adjust itself to the first severe jolt which it received through the discovery of argon and helium, and three years later, of other inactive, monatomic elements. The necessity for readjustment here had been in part foreseen. The abrupt change in the progression of the elements from strongly electro-negative fluorine to strongly electro-positive sodium, and, in general, the transition *per saltum* from period to period had been discussed by Reynolds and others. It needed explanation and was impossible mathematically except by passing through zero or infinity. Some, as Sedgwick and de Boisbaudran, seem to have predicted such transition elements, and when argon was discovered it was not difficult for Julius Thomsen

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and de Boisbaudran to arrange an entire zero group with approximate atomic weights three years before Ramsay's brilliant discovery of the other inactive gases.

There are other anomalies in the system which are difficult to explain with the accepted tabulation. Such, for instance, is the existence of the rare earths, now some sixteen in number, so closely alike chemically and so different from other chemical individuals. The more they are studied, the less possible does it seem to fit them in any vacant places in the table. Meyer has recently suggested that they may form a miniature periodic system in themselves reproducing the relations of the main system. But a more serious breakdown in the supposed fundamental principle of the system comes in the relative position of such elements as argon and potassium, cobalt and nickel, tellurium and iodine. After most exhaustive investigation of their atomic weights it has become evident that these can not be used in deciding the relative order and at the same time have these elements fall into the proper grouping with those elements chemically most nearly related to them. So the order of the atomic weights has been tacitly abandoned and the superior determining power of the chemical characteristics acknowledged. This can only mean that the mass of the atom is not the sole, nor indeed the chief, determining variable, and it would seem that the search for the latter can only be ended by the solution of the problem as to the nature of the atom itself.

Certain clews to this have undoubtedly been in our hands for a long time, but their leading was not clear and the thought of them baffling. Such, for instance, were the facts that by taking an atom of nitrogen and four of hydrogen a grouping of atoms was obtained which behaved in general as an atom and was the analogue of potassium. Or, again, carbon and nitrogen give us an analogue of chlorine—and so with compound radicals in general. But while both building and tearing down again were easy, they seemed to throw no light on how those we could not tear down were once built up.

Still another thought-inspiring fact which would seem to have important bearing on the nature of the atom and hence the meaning of the periodic system is the ease with which certain elements by a change of valence change their chemical character and form distinctive series of salts as if they had been transformed into different elements. This causes some confusion and what would ordinarily be called forcing in the present tabulation of the system, and it will be recalled that Mendeleeff, in his earlier tables, actually placed certain of the metals, as copper and mercury, in two different groups, assigning each two different places. Signs are seen in the work of Barbieri and others of a tendency to place certain of the elements in different groups according to valence.

I believe that one should keep in mind the idea involved in Patterson-Muir's definition of an element as a collection or group of properties. Thus there are weight, electro-chemical nature, affinity, valence and other properties by which we recognize it and differentiate it from other elements and to which our knowledge of it is necessarily limited. There is a more or less definite gradation in these properties from element to element, showing an inter-relationship, and yet scarcely in itself justifying the conclusion that any one property determines the others or that they are dependent upon it. While it is true that it is hardly possible to dissociate these properties from some conception of matter, such conception has not yet reached its ultimate analysis and until it has we are dealing with the recognized properties alone.

In the same year in which the periodic system was forced to adjust itself to a zero group another discovery was entering upon its marvellous development which was to open up new views as to the nature of matter and radically affect the system. The remarkable and illuminating results obtained in the study of radio-active substances are paving the way for an understanding of the laws on which this system is based.

Radio-activity was regarded by Mme. Curie as an atomic property and this was the guiding thread which led to the discovery of radium. Of course, this preceded by a number

of years Rutherford's announcement of his theory of successive transformation or the disintegration of the atom. It is a question whether the fact that an atom is undergoing disintegration is to be regarded as a property in the same sense as the mass, valence, etc., but so long as this change can not be induced, changed or stopped and is known to take place only in the case of a fraction of the elements it is certainly distinctive and may be called a property for lack of a better name. There is, however, undoubtedly a cause for this disintegration and this instability may be due to some inherent property of the atom.

At present there are some thirty-seven radio-active bodies known, with the possibility of still others being identified. Each has distinctive radio-active properties. For a number of these the chemical and physical properties are known. Each is an atom hitherto unknown and must be considered a new element. Of course, the present accepted arrangement of the periodic system does not provide for so many additional elements and indeed is rather hopeless for even the sixteen rare earth elements. What is to be done with this embarrassment of riches?

Soddy's study of the grouping in well-known families of a number of the better known radio-active elements according to their chemical properties, combined with a consideration of the kind of disintegration by which it was produced led him to a generalization which would enable one to place correctly any radio-active element whose source was known, and at the same time give an approximation as to its atomic weight.

Fajans arrived at the same generalization independently from an examination of the electro-chemical evidence, finding that the product of an α ray change was more electro-positive, while that of a β ray change was more electro-negative. Similar conclusions from various evidence were reached by Fleck and Russell.

The generalization is as follows:

When an α particle is expelled it carries with it two atomic charges

of positive electricity and the expulsion of these two positive charges from the atom affects the valency of the product, as Fajans has pointed out, just as in ordinary electro-chemical changes of valency. If the atom were initially in Group IV., for example, its ion is tetravalent and carries four atomic charges of positive electricity. Two such charges having been expelled with the α particle, the product is in the di-valent Group II., non-separable from radium. The mass in this case is four units less. So with the β ray change. The β particle is a negative electron and the loss of this single atomic charge of negative electricity increases the positive valency of the product by one. Radium B, for example (in Group IV.), expels a β particle and becomes radium C (in Group V.). Whenever two or more radio-elements fall in the same place in the Periodic Table, then, independently of all considerations as to the atomic mass, the nature of the parent element, and the sequence of changes in which they result, the elements in question are chemically non-separable and identical. As will later appear, this identity extends also to most of the physical properties such as volatility and spectrum reactions.*

To express this "newly revealed complexity of matter," Soddy has suggested the word isotope. A group of two or more elements occupying the same place in the periodic table, differing in atomic weight yet chemically non-separable, is isotopic. There are possibly seven such elements isotopic with lead. Radium is one of four isotopes. The chemistry of thirty-seven radio-elements is thus reduced to a smaller number of about ten types.

Two fundamental changes in the old views as to the system are indicated here. First, the position of an element is not fixed but can be changed in either of two ways—by a change in valence (which, as is well known, can be brought about in various ways), and again by disintegration due to ray-emission. Secondly, more than one element can occupy a given position in the system. This is independent of the atomic weight, but such elements are chemically inseparable. This involves the giving up of all idea of the properties being functions of the atomic weights and necessitates the formulation of the law anew.

The place occupied by an atom is not solely determined

* Soddy, "The Radio-active Elements and the Periodic Law."

by its mass but by its electrical content as well. According to Soddy, the system represents the chemical character of matter as the function of two variables instead of one. The electrical content is the essential variable in horizontal columns and mass is the essential in vertical columns.

It is somewhat early to raise the question as to whether all elemental atoms are the result of disintegration processes, or, conversely, of synthesis, but in any case the old puzzle remains as to their great irregularity in weight relations if the most accurate chemical determinations are to be relied upon. If the time should arrive when they could be calculated, chemists would naturally return to hydrogen as the standard. Certainly, at present these weights present no simple synthetic relations.

An explanation of this is perhaps at hand if the view of Soddy (and of Crookes at an earlier period and from a different standpoint) is accepted, namely, that in atomic weight determinations it is not a natural constant that is gotten but a mean value of non-homogeneous masses. In other words, the weight may represent the average of various isotopic atoms and not the absolute weight of identical atoms.

It is very fortunate that the simple expedient of arranging the elements in the order of their atomic weights could give the early workers so nearly correct a view of the periodic system. It would probably have remained hidden for a long time if this had not been so prominent a factor in determining the proper sequence. There is undoubtedly a proper sequence. This has been settled hitherto chiefly by consideration of the atomic weight, but also by examination into the relationship existing between the elements. For instance, the order of atomic weights would be iodine and then tellurium, but chemically tellurium belongs to Group VI and iodine to Group VII. Therefore, the atomic weight order is reversed.

The sequence numbers of the elements, or atomic numbers as they are called, assume a new practical and theoretical importance. Within twenty years after the announcement of the periodic system, some, as Fedaroff, had sought to attach

importance to these numbers, but the efforts had little to commend them. Lately it has been suggested by van den Broek that this is a fundamental and important number. Beginning with 1 for H, the numbers would be 2 for He, 3 for Li, 4 for Be, etc. The question then naturally arises, can these numbers be reliably determined without reference to the atomic weights and correcting the manifest mistakes made in following the simple order of these weights?

One method for doing so, though with limitations, lies in the measuring of the scattering of the α particles when passing through different kinds of matter. Geiger found that the angle of the scattering seemed to depend very largely upon the atomic weight of the scattering metal. A very small fraction are scattered through such a large angle that they return on the side of incidence. This deflection is, of course, both a volume and surface effect. For equal thickness of screen calculations based on Rutherford's conception of the atom and his belief that this large angle scattering is due to the near approach of the positively charged α particle to the positive nucleus of the atom of the screen would make the scattering vary as the product of the density by the atomic weight. Thus Rutherford calculated that the scattering by gold should be about fifty times that by aluminium. This has been confirmed by the experiments of Geiger and Marsden, and the relative scattering has been determined for a large number of elements. The phenomenon is manifestly one determined by the electrical content of the atom.

The nuclear charge of the Rutherford atom can be calculated from the α particle scattering at various angles. This charge is found to be one-half the atomic weight multiplied by the charge of an electron. The same value was reached by Barkla by observations on X-rays. Soddy concludes that it is the nuclear charge rather than the atomic mass which fixes the position of the element, basing his conclusion largely upon the work of Barkla, Sadler and Moseley, which will be briefly outlined further on. This in reality agrees with the hypothesis of van den Broek that the number of electrons in

an atom in the neutral state determines the place of the element if hydrogen has one electron and one nuclear unit charge, helium two electrons and two nuclear unit charges, etc.

The direct method then is a combination of the work of Bragg, Barkla and Sadler, and Moseley. Making use of the work of those first mentioned, Moseley photographed the spectra obtained by the cathode-ray bombardment of a number of elements, the X-rays thus produced being reflected and defined from a crystal face. The frequencies of the vibrations could be determined and this frequency was found proportional to the square of the atomic number. That is, there was a definite shifting in the direction of shorter wave-length in the spectrum of an element from that of the one next above it in the list.

The graphic representation of the system has never been satisfactory in spite of the many efforts to solve it. It is especially difficult to bring out the facts by any representation on a plane surface. The faults of the Mendeleeff table can readily be seen, and they make it very desirable to secure a better mode of expression. And yet it is difficult to use the three dimensions of space so that the average student can grasp the whole. Soddy's lemniscate curve certainly has its good points. This may be compared with the arrangement of Rydberg. It can not be claimed yet, however, that the law or laws underlying this system are known and well understood, and until such time a complete and satisfactory graphic representation is scarcely to be expected. We can agree at least that progress is being made toward such an understanding.

Chapel Hill, N. C.

A LIST OF HOMOPTERA OF NORTH CAROLINA

BY Z. P. METCALF

The present list is not complete in any sense of the word but simply represents our present knowledge of the species of Homoptera which have been collected in this State. The two sources of our knowledge of the Homoptera of the State have been the published writings of the American Hemipterists Uhler, Osborn, Van Duzee and Ball and the collections made in the State. The largest collection of Homoptera in the State is that of the State Department of Agriculture which owes its inception and growth to the enthusiasm of the chief of the Division of Entomology, Mr. Franklin Sherman, Jr. The large number of times the initials F. S. occur after locality data will show clearly that Mr. Sherman has collected these small insects assiduously in practically all parts of the State. This collection was also enriched by the addition of numerous specimens collected in a trip during the month of September, 1909, when the writer collected at Blowing Rock, Yonahlossee Road, Grandfather Mountain, Balsam, Waynesville and Montreat.

The collection of the Division of Zoology and Entomology of the College of Agriculture contains a good series of most of the species that have been taken at Raleigh together with others which have been acquired by purchase.

The collection of Mr. A. H. Manee made at Southern Pines is rich, especially in those forms that occur further South.

In nearly all cases individual localities are given as our collecting has not been extensive enough to warrant our drawing any very extensive conclusions. The month for convenience has been divided into three parts, early, mid and late. In our later collecting in the mountains careful records have been kept of the elevations at which specimens have been taken and the mountains have been divided into 500 foot zones for this purpose.

The initials of the person collecting the specimen is usually given after each locality and date. These initials refer to the following persons:

*F*ranklin *S*herman, Jr., State Entomologist.
R. S. *W*oglum, formerly Assistant State Entomologist.
L. M. *S*mith, formerly Assistant State Entomologist.
G. M. *B*ently, formerly Assistant State Entomologist.
C. L. *M*etcalf, formerly Assistant State Entomologist.
C. S. *B*rimley, Zoologist, Raleigh.
A. H. *M*ance, Southern Pines.

More collecting has been done at Raleigh than all other points combined but rather extensive collecting has been done at Beaufort, Lake Waccamaw, Southern Pines, Stem, Statesville, Blowing Rock, Yonahlossee Road, Grandfather Mountain, Montreat, Swannanoa, Highlands, Tryon, Canton, Sunburst (Haywood County), Balsam, Waynesville.

Some of our specimens have been identified by Van Duzee, Heideman, Osborn and Ball, but most of the specimens have been examined by the writer and a majority of the species have been identified by him save in the Family Cicadidæ where the identifications stand substantially as made by Mr. Heideman.

FAMILY CICADIDAE

CICADA CANICULARIS, HARRIS (?)
A single specimen from Raleigh seems to be nearer this species than any other. L. Sept. C. S. B.

CICADA LINNEI, S. & G.
Raleigh, Nov. G. M. B.; E. Oct. F. S.; E. Aug. Z. P. M.; L. Sept. G. M. B.

CICADA LYRICEN, DeG.
Raleigh, E. July, F. S. Andrews, L. July, F. S.

CICADA RESONANS, WALK.
Southern Pines. A. H. M.

Cicada auletes, Germ.
Raleigh, Abundant July to Mid Sept. C. S. B.
Southern Pines, M. Aug. A. H. M.
Lake Toxaway, Mrs. Slosson.

Cicada pruinosa, S. & G.
Beaufort, Mid. Aug. F. S.

Cicada reperta, Uhl.
Wilmington, L. July, J. P. S.

Cicada sayi, S. & G.
Raleigh, L. June to L. Oct. Common.

Cicada septendecem, Linn.
Several distinct broods occur in the State.

Melampsalta parvula, Say.
Southern Pines, June & July, A. H. M.
Aberdeen, June, F. S.
Watkins, E. July. Z. P. M.

Tettigia hieroglyphica, Say.
Beaufort, L. June.
Southern Pines, June and July.
Rocky Mount.

FAMILY MEMBRACIDAE
SUB-FAMILY—SMILIINAE
TRIBE—CERASINI

Acutalis semicrema, Say.
Montreat, L. Sept. 2500-3000 ft. Z. P. M.
Swannanoa, Mid. July. Z. P. M.
Waynesville, Mid. Sept., 2500-3000 ft. Z. P. M.
Stem, E. October. Z. P. M.

Acutalis tartarea, Say.
Raleigh, Mid. October, G. M. B.; L. June, F. S.
Waynesville, Mid. Sept. 3000 ft. Z. P. M.
Waynesville, Rocky Knob. 4000-5000 ft. Mid. Oct.
Z. P. M.

CERESA BREVITYLUS, VAN D.
Henderson, June, F. S.
Sunburst, May, 3000-3500 ft. F. S.
Raleigh, E. and Mid. May, Z. P. M.
Raleigh, Mid. April, F. S.

CERESA BOREALIS, FAIRM.
Blowing Rock, Sept. S. W. F.
Yonahlossee Road, Mid. Sept. C. L. M.
Montreat, 2500-3000 ft. L. Sept. Z. P. M.
Balsam, Mid. Sept. 4500-5000 ft. Z. P. M.

CERESA BUBALUS, FABR.
Washington, Mid. July, F. S.
Raleigh, Aug. C. S. B.

CERESA CONSTANS, WALK.
Waynesville, Rocky Knob, 3000-3500 ft. Mid. Sept. Z. P. M.

CERESA DICEROS, SAY.
Marion, Mid. July, F. S.

CERESA ILLINOIENSIS, GODG.
Newton, May, F. S.

CERESA PALMERI, VAN D.
Waynesville, L. Sept., about 3000 ft., Z. P. M.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

CERESA TAURINA, FITCH.
Waynesville, Mid. Sept., 3000 ft., Z. P. M.

CERESA UNIFORMIS, FAIRM.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

MICRUTALIS CALVA, SAY.
Raleigh, L. July, Z. P. M.; E. Sept., F. S.
Balsam, Mid. Sept., 3000 to 5000 ft., Z. P. M.

MICRUTALIS ILLINOIENSIS, GODG.
Raleigh, E. Sept., F. S.; Mid. Sept., Z. P. M.

STICTOCEPHALA DIMINUTA, VAN D.
Raleigh, E. July, F. S.

STICTOCEPHALA FESTINA, SAY.
Raleigh, E. Oct. to E. Nov., Z. P. M.
STICTOCEPHALA INERMIS, FABR.
N. C., Z. P. M.
STICTOCEPHALA LUTEA, WALK.
Raleigh, E. Aug., Z. P. M.
STICTOCEPHALA ROTUNDATA, STAL.
Raleigh, E. Nov., Z. P. M.
STICTOCEPHALA SUBSTRIATA, WALK.
N. C., Van D.
Southern Pines, A. H. M.

TRIBE—TELAMONINI, GODG.

ARCHASIA BELFRAGEI, STAL.
Southern Pines, A. H. M.
ARCHASIA GALEATA, FABR.
Southern Pines, E. June, R. S. W.; Mid. May, A. H. M.

CARYNOTA MARMORATA, SAY.
Raleigh, E. July, Z. P. M.
Blowing Rock, L. July, G. M. B.
Hendersonville, June, F. S.

CARYNOTA MERA, SAY.
Raleigh, L. Oct., on Pecan, C. L. M.

CARYNOTA PORPHYREA, FAIRM.
Raleigh, Mid. June, F. S.

HELIRIA CRISTATA, FAIRM.
N. C., Van D.

TELAMONA WESTCOTTI, GODG.
N. C., Van D.

TELAMONA UNICOLOR, FITCH.
Raleigh, Mid. May, H. H. Hume.

TELAMONA AMPELOPSIDIS, HARRIS.
N. C., Riley.

TELAMONA MONTICOLA, FABR.
N. C., Riley.

THELIA BIMACULATA, FABR.
N. C., Walker.

TRIBE—SMILINI, GODG.

SOMILIA CAMELUS, FABR.
Southern Pines, A. H. M.

ATYMNA CASTANEAE, FITCH.
Cashiers, Mid. June, F. S.

ATYMNA QUERCI, FITCH.
Blowing Rock, L. July, G. M. B.
Highlands, E. Sept., R. S. W.

ATYMNA INORNATA, SAY.
N. C., Van D.

CYRTOLOBUS FENESTRATUS, FITCH.
Raleigh, E. May, Z. P. M.
Blowing Rock, L. June, L. July, F. S.

CYRTOLOBUS MUTICUS, FABR.
N. C., Van D.

CYRTOLOBUS SCULPTUS, FAIRM.
N. C., Van D.

CYRTOLOBUS VAU, SAY.
N. C. Riley.

CYRTOLOBUS DISCOIDALIS, EMM.
Balsam, W. J. Palmer.

CYRTOLOBUS TUBEROSUS, FAIRM.
N. C., Z. P. M.

OPHIDERMA FLAVICEPHALA, GODG.
N. C., Z. P. M.

OPHIDERMA, FLAVA, GODG.
N. C., Z. P. M.

TRIBE POLYGLYPTINI

ENTYLIA BACTRIANA, GERM.
Balsam, L. Sept., 2500-5000 ft., Z. P. M.

ENTYLIA CONCISA, WALK.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

ENTYLIA SINUATA, FABR.
Stem, E. Oct., Z. P. M.
Balsam, Mid. Sept., 4500-5500 ft., Z. P. M.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.

PUBLILIA CONCAVA, SAY.
Hendersonville, June, F. S.
Montreat, 2500-3000 ft., L. Sept., Z. P. M.
Black Mountain, L. May, F. S.

PUBLILIA RETICULATA, VAN D.
Hendersonville, June, F. S.
Black Mountain, L. May, F. S.
Balsam, L. Sept., 3500-5000 ft., Z. P. M.
Montreat, 2500-3000 ft., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.

VANDUZEA ARQUATA, SAY.
Raleigh, Mid. June, Z. P. M.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.
Blowing Rock, L. July, G. M. B.

SUB-FAMILY HOPLOPHORINAE STAL

PLATYCOTIS QUADRIVITTATA, SAY.
Raleigh, E. May, Z. P. M.
Blowing Rock, Sept., S. W. F.

PLATYCOTIS SAGITTATA, GERM.
Kawana, Mid. Oct., E. C. Robins.

SUB-FAMILY MEMBRACINAE STAL

CAMPYLENCHIA LATIPES, SAY.
Raleigh, Mid. June, E. July, L. July, E. Aug., Z. P. M., Mid. Aug., C. L. M.; E. July, F. S.

Waynesville, Rocky Knob, 4000-4500 ft., Mid. Sept., Z. P. M.

Enchenopa binotata, Say.

Montreat, L. Sept., 2500-3000 ft., Z. P. M.

Waynesville, Rocky Knob, Mid. Sept., 4000-5000 ft., Z. P. M.

Tylopelta brevis, Van D.

Raleigh, Z. P. M.

SUB-FAMILY CENTROTINAE STAL

Microcentrus caryae, Fitch.

Waynesville, Rocky Knob, Mid. Sept., 4500-5000 ft., Z. P. M.

FAMILY FULGORIDAE
SUB-FAMILY FULGORINAE

Cyrpoptus belfragei, Stal.

Havelock, L. May, 1907, L. M. S.
Raleigh, E. July, 1909, Z. P. M.

Poiocera fuliginosa, Uhler.

Raleigh, L. Oct., 1902, F. S., on sumach.
Southern Pines, Oct., 1908, A. H. M.

SUB-FAMILY DICTYOPHARINAE

Dictyophara lingula, Van D.

Raleigh, E. to Mid. Aug., Z. P. M.; E. Sept., F. S.

Dictyophara microrhina, Walk.

Southern Pines, Mid. Sept., A. H. M.

Phylloscelis atra, Germ.

Raleigh, L. July, Mid. Sept., Z. P. M.

Phylloscelis pallescens, Germ.

Raleigh, L. July, Z. P. M. More common than the preceeding.

SCOLOPS ANGUSTATUS, UHLER.
Highlands of N. C., Uhler.
Raleigh, E. to L. July, Z. P. M.

SCOLOPS DESSICATUS, UHLER.
Raleigh, E. July, Z. P. M.; E. Oct., F. S.

SCOLOPS PERDIX, UHLER.
Raleigh, E. July, Z. P. M.

SCOLOPS SULCIPES, SAY.
Yonahlossee Road, E. Sept., C. L. M.

SUB-FAMILY CIXIINAE

OLIARUS HUMILIS, SAY.
Raleigh, E. July, Mid. Aug., Z. P. M.

OLIARUS QUINQUCILINEATUS, SAY.
Southern Pines, Mid. May, A. H. M.

OLIARUS VICARIUS, WALK.
Southern Pines, Mid. May, A. H. M.

OLIARUS COMPLECTUS, BALL.
N. C., Z. P. M.

OECLEUS DECENS, STAL.
Raleigh, Mid. June, E. Aug., Z. P. M.
Southern Pines, E. May, A. H. M.

BOTHRIOCERA BICORNIS, FAB.
N. C., Uhler.

BOTHRIOCERA TENEALIS, BURN.
Raleigh, E. July, Mid. July, Z. P. M.; C. L. M.; L. June, F. S.

CIXIUS STIGMATUS, SAY.
Grandfather Mountain, Mid. Sept., 5000-5500 ft., Z. P. M.

CIXIUS PINI, FITCH.
Raleigh, E. May, Z. P. M.

MYNDUS PICTIFRONS, STAL.
Hendersonville, July, 1907, F. S.

SUB-FAMILY DELPHACINAE

BOSTAERA NASUTA, BALL.
Southern Pines, L. July, A. H. M.
Willard, L. July, Z. P. M.

STENOCRANUS DORSALIS, FITCH.
Hendersonville, June, F. S.

STENOCRANUS LAUTUS, VAN D.
Raleigh, Mid. Aug., E. Sept., Z. P. M.
Hendersonville, June, F. S.

KELISIA AXIALIS, VAN D.
Stem, E. Oct., Z. P. M.

STOBAERA TRICARINATA, SAY.
Raleigh, L. March, E. Oct.
Statesville, Mid. April, F. S.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Waynesville, 4000-5000 ft., E. Sept., Z. P. M.

PEREGRINUS MAIDIS, ASH.
Raleigh, L. Sept., C. L. M.

PISSONOTUS BRUNNEUS, V. D.
Raleigh, L. July, F. S.

LIBURNIA PELLUCIDA, FABR.
Raleigh, E. Sept.

LIBURNIA PUELLA, VAN D.
Raleigh, E. Aug., C. L. M.
Grandfather Mountain, about 4000 ft., Sept., F. S.
Hendersonville, June, F. S.
Andrews, Mid. May, F. S.

LIBURNIA ORNATA, STAL.
Raleigh, E. May to E. Nov., Z. P. M.
Stem, E. Oct., Z. P. M.

Grandfather Mountain, 4000-5000 ft., E. Sept., Z. P. M.
Blantyre, May, F. S.
Hendersonville, June, F. S.

LIBURNIA KILMANI, VAN D.
Raleigh, Mid. Sept., Z. P. M.

LIBURNIA CONSIMILIS, VAN D.
Hendersonville, F. S.

LIBURNIA LAMINALIS, VAN D.
Hendersonville, June, F. S.

SUB-FAMILY ACHILIINAE

CATONIA CINCTIFRONS, FITCH.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Waynesville, Mid. Sept., 3500-4000 ft., Z. P. M.
Montreat, L. Sept., 2500-3500 ft., Z. P. M.

CATONIA IMPUNCTATA, FITCH.
Raleigh, Mid. July, 1912, C. L. M.

CATONIA PICTA, VAN D.
N. C., Z. P. M.

ELEDIPTERA OPACA, SAY.
Southern Pines, Mid. Oct., A. H. M.

SUB-FAMILY DERBINAE

AMALOPOTA FITCHII, VAN D.
Raleigh, L. Aug., Z. P. M.
Red Springs, L. June, F. S.

ANOTIA BURNETII, FITCH.
Raleigh, E. Sept., C. S. B.

OTIOCERUS COQUEBERTII, KIRBY.
Canton, June, F. S.

LAMENIA VULGARIS, FITCH.
Raleigh, L. May, L. Aug., Z. P. M.
Balsam, Mid. Sept., above 4000 ft., Z. P. M.

Waynesville, Mid. Sept., 3500-4000 ft., Z. P. M.
Beaufort, Mid. June, F. S.

LAMENIA MACULATA, VAN D.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.

LAMENIA EDENTULA, VAN D.
Raleigh, Mid. Aug., E. Sept., Z. P. M.

LAMENIA OBSCURA, BALL.
N. C., Van Duzee.

SUB-FAMILY ISSINAE

BRUCHOMORPHA OCULATA, NEWM.
Raleigh, Mid. Aug., Mid. Sept., Z. P. M.

BRUCHOMORPHA DORSATA, FITCH.
Raleigh, Mid. Aug., Z. P. M.

BRUCHOMORPHA SUTURALIS, MEL.
Raleigh, E. Sept., Z. P. M.

BRUCHOMORPHA TRISTIS, STAL.
Raleigh, L. July, Mid. Sept., E. Nov., Z. P. M.

THIONIA BULLATA, SAY.
Raleigh, E., L. July, Z. P. M.
Waynesville, Mid. Sept., at 3000-3500 ft., Z. P. M.
Balsam, Mid. Sept., 4500-5000 ft., Z. P. M.
Andrews, Aug., F. S.

THIONIA SIMPLEX, GERM.
Waynesville, Mid. Sept., 3000-3500 ft., Z. P. M.

THIONIA ELLIPTICA, GERM.
Raleigh, E. July, F. S.

SUB-FAMILY ACANALONINAE

ACANALONIA LATIFRONS, WALK.
Southern Pines, July, S. W. F.

ACANALONIA CONICA, SAY.
Raleigh, L. Oct., C. S. B.

AMPHISCEPA BIVITTATA, SAY.
Raleigh, L. July, E. Aug., Z. P. M.; E. Aug., C.L.M.
Waynesville, Mid. Sept., 3000-3500 ft., Z. P. M.

SUB-FAMILY FLATINAE

ORMENIS PRUINOSA, SAY.
Raleigh, E. to L. July, Z. P. M.
Tarboro, Mid. July, F. S.
Statesville, Aug., Z. P. M.
Waynesville, Mid Sept., 3000 to 3500 ft., Z. P. M.

ORMENIS SEPTENTRIONALIS, SPIN.
Raleigh, E. to L. July, Z. P. M.: Aug., C. S. B.
Statesville, Aug., Z. P. M.
Asheville, Sept., F. S.
Elkin, June, F. S.

ORMENIS VENUSTA, MEL.
Raleigh, E. July, F. S.
Southern Pines, Aug., R. S. W.
Statesville, Aug., Z. P. M.

CYARDA MELICHARI, VAN D.
Southern Pines, L. May., A. H. M.

FAMILY CERCOPIDAE
SUB-FAMILY CERCOPINAE

TOMASPIS RUBRA, LINN.
Raleigh, L. July to L. Aug., Z. P. M.
Beaufort, E. June, F. S.
Hamlet, L. Oct.,F. S.

SUB-FAMILY APHROPHORINAE

APHROPHORA SARATOGENSIS, FITCH.
Beaufort, Mid. June, F. S.

APHROPHORA SIGNORETII, FITCH.
Blowing Rock, L. June, 4000 to 4500 ft., F. S.

APHROPHORA QUADRINOTATA, Say.
Highlands, E. Sept.
Canton, June, F. S.
Montreat, L. Sept., 2500-3000 ft., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.

LEPYRONIA QUADRANGULARIS, Say.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Waynesville (Rocky Knob), 3000-5000 ft., Z. P. M.
Waynesville, 2500-3500 ft., Z. P. M.
Yonahlossee Road, E. Sept., 4000-5000 ft., Z. P. M.
Grandfather Mountain, about 4000 ft., Z. P. M.

PHILAENUS SPUMARIUS, Linn.
Canton, June, F. S.
Yonahlossee Road, Mid. Sept., 4000-5000 ft., Z. P. M.
Blowing Rock, E. Sept., C. L. M.

CLASTOPTERA OBTUSA, Soy.
Raleigh, L. June, F. S.
Greensboro, Mid. Aug., F. S.
Hendersonville, June, F. S.
Balsam, Mid. Sept., 2500-4000 ft., Z. P. M.
Waynesville, Mid. Sept., 2500-3000 ft., Z. P. M.
Yonahlossee Road, E. Sept., 4000-5000 ft.

CLASTOPTERA PROTEUS, Fitch.
Highlands, July, F. S.
Blowing Rock, July, F. S.

CLASTOPTERA XANTHOCEPHALA, Germ.
Raleigh, Mid. May to E. Nov., Z. P. M.
Beaufort, June, F. S.
Grandfather Mountain, Mid. Sept., 5000-5500 ft., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.
Sunburst, May, 3000-3500 ft., F. S.
Balsam, Mid. Sept., 4000-5000 ft., Z. P. M.
Statesville, Mid. April, F. S.

SUPER-FAMILY JASSOIDEA
FAMILY BYTHOSCOPIDAE

ONCOPSIS FENESTRATUS, FITCH.
N. C., Van D.

ONCOPSIS DISTINCTUS, VAN D.
N. C., Van D.

ONCOPSIS NIGRINASI, FITCH.
N. C., Van D.

ONCOPSIS VARIABILIS, FITCH.
Blowing Rock, L. July, G. M. B.

PEDIOPSIS VIRIDIS, FITCH.
Hendersonville, June, F. S.

IDIOCERUS ALTERNATUS, FITCH.
Southern Pines, Mid. May, H. H. M.

AGALLIA QUADRIPUNCTATA, PROV.
N. C., Z. P. M.

AGALLIA SANGUINOLENTA, PROV.
Raleigh, L. Jan., Mid. April, F. S.; Mid. Sept., Z. P. M.
Stem, E. Oct., Z. P. M.
Southern Pines, Jan., F. S.
Balsam, Mid. Sept., 3500 to 4000 ft., Z. P. M.
Grandfather Mountain, about 5000 ft., Mid. Sept., Z. P. M.
Waynesville, about 3000 ft, Z. P. M., Mid. Sept.

AGALLIA CONSTRICTA, VAN D.
Raleigh, L. July to Mid. Sept., Z. P. M., E. July, F. S.
Hendersonville, June, F. S.
Jefferson, Mid. Aug., F. S.
Grandfather Mountain, about 5000 ft, Mid. Sept. Z. P. M.
Andrews, Mid. May, F. S.

Balsam (Jones' Peak), about 4000 ft., Mid. Sept., Z. P. M.
Waynesville (Rocky Knob), 4000 to 5000 ft., Mid. Sept., Z. P. M.

AGALLIA NOVELLA, SAY.
Raleigh, L. June, Z. P. M.
Hendersonville, June, F. S.
Blowing Rock, L. July, G. M. B.; E., Sept., Z. P. M.
Waynesville, Mid. Sept., 2500 to 3000 ft., Z. P. M.
Balsam, 4500 to 5000 ft., Mid. Sept., Z. P. M.
Andrews, Mid. May, F. S.

FAMILY TETTIGONIELLIDAE
SUB-FAMILY TETTIGONIELLINAE

AULACIZES IRRORATA, FAB.
Hendersonville, June, F. S.
Highlands, E. Sept., R. S. W.
Beaufort, Mid. June, F. S.
Red Springs, L. June, F. S.
Grandfather Mountain, about 4000 ft., F. S.

ONCOMETOPIA UNDATA, FABR.
Raleigh, E. July, F. S.
Beaufort, E. June, F. S.
Ivanhoe, Mid. July, L. M. S.
Lillington, E. June, L. M. S.
Hendersonville, June, F. S.
Highlands, E. Sept., R. S. W.

ONCOMETOPIA LATERALIS, FABR.
Southern Pines, L. March, F. S.; Jan., F. S.; L. June, F. S.
Norlina, Mid. July, S. W. F.
Lake Waccamaw, Mid. April, F. S.
Blowing Rock, Mid. June, F. S.
Statesville, Mid. April, F. S.
Fayetteville, Mid. July, S. W. F.
Red Springs, L. Sept., F. S.

Goldsboro, April, G. M. B.
Stem, E. Oct., Z. P. M.

TETTIGONIELLA GOTHICA, SIGN.
Balsam, 3500 to 4000 ft., Mid. Sept., Z. P. M.
Montreat, L. Sept., 2500 to 3000 ft., Z. P. M.
Waynesville, Mid. Sept., about 3000 ft., Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., 3500 to 5000 ft., Z. P. M.

TETTIGONIELLA OCCATORIA, SAY.
Raleigh, L. June, Z. P. M.; E. Aug., C. L. M.
Black Mountain, L. May, F. S.

KOLLA BIFIDA, SAY.
Raleigh, E. May to E. Nov., Z. P. M.
Hendersonville, June, F. S.
Balsam (Jones' Peak), above 4000 ft., Mid. Sept., Z. P. M.
Waynesville, Mid. Sept., Z. P. M., from 2500 to 4000 ft.

KOLLA TRIPUNCTATA, FITCH.
Raleigh, E. Aug., C. L. M.
Waynesville (Rocky Knob), 4000 to 5000 ft., Mid. Sept., Z. P. M.
Balsam, 2500 to 5000, Mid. Sept., Z. P. M.

HELOCHARA COMMUNIS, FITCH.
Blowing Rock, E. Sept., Z. P. M., 3500 to 4000 ft.
Grandfather Mountain, Mid. Sept., Z. P. M., about 5000 ft.; Mid. Sept., above 4000 ft., F. S.
Balsam, 3500 and 5000 ft., Mid. Sept., Z. P. M.

DIEDROCEPHALA COCCINEA, FORST.
Raleigh, E. Aug., C. L. M.
Highlands, E. July, F. S.
Cane River, Sept., F. S.
Balsam, 4000 to 5000 ft., Z. P. M.
Montreat, 2500 to 3000 ft., L. Sept., Z. P. M.
Wilmington, Mid. May, F. S.

Blowing Rock, L. July, G. M. B.; E. Sept., Z. P. M., 3500 to 4000 ft.
Hendersonville, June, F. S.
Grandfather Mountain, 4000 to 5000 ft., E. Sept., Z. P. M.

DIEDROCEPHALA VERSUTA, SAY.
Raleigh, L. June to E. Aug., Z. P. M.
Charlotte, L. July.
Southern Pines, L. June.
Balsam, 3500 to 4000 ft., Mid. Sept., Z. P. M.
Hendersonville, June, F. S.
Waynesville, about 3000 ft., Mid. Sept., Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., 4000 to 5000 ft., Z. P. M.

DRAECULOCEPHALA MOLLIPES, SAY.
Raleigh, L. March to E. Nov., Z. P. M.
Balsam, Mid. Sept., 3500 to 5000 ft., Z. P. M.
Charlotte, L. July.
Blantyre, E. May, F. S.
Andrews, Mid. May, F. S.
Wallace, L. March, F. S.
Jefferson, Mid. Aug., F. S.
Grandfather Mountain, above 4000 ft., Sept., F. S.
Montreat, L. Sept., 2500 to 3000 ft., Z. P. M.
Stem, E. Oct., Z. P. M.
Swannanoa, Mid. July, Z. P. M.
Waynesville, L. Sept., 2500 to 3000, Z. P. M.

DRAECULOCEPHALA 7-GUTTATA, WALK.
Raleigh, E. Nov., Z. P. M.; E. Aug., C. L. M.

DRAECULOCEPHALA 7 GUTTATA, WALK.
Raleigh, E. July, L. March, Z. P. M.

DRAECULOCEPHALA RETICULATA, SIGN.
Raleigh, E. March, F. S.; L. Sept. to L. Nov,, Z. P. M.
Southern Pines, Jan., F. S.

EUCANTHUS ACUMINATUS, FABR.
Canton, June, F. S.

SUB-FAMILY GYPONINA

XEROPHLOEA VIRIDIS, FABR.
Raleigh, L. July, Z. P. M.

XEROPHLOEA MAJOR, BAK.
Raleigh, Mid. Sept., E. Oct., Z. P. M.
Yonahlossee Road, Mid. Sept., C. L. M.

GYPONA 8-LINEATA, SAY.
Raleigh, E. to Mid. Sept., Z. P. M.
Highlands, Sept., F. S.
Andrews, L. July, F. S.
Southern Pines, L. June, A. H. M.
Waynesville, Mid. Sept., about 3000 ft., Z. P. M.
Balsam, 5000 to 5500, Mid. Sept., Z. P. M.

GYPONA STRIATA, BURM.
Raleigh, Mid. Oct., G. M. B.; L. Aug., Z. P. M.
Highlands, E. July, F. S.

GYPONA PECTORALIS, SPANGB.
Raleigh, June, F. S.
Cedar Grove, Mid., June, F. S.
Black Mountain, L. May, F. S.

GYPONA WOODWORTHI, VAN D.
Balsam, Mid. Sept., about 4000 ft., Z. P. M.

PENTHEMIA AMERICANA, FITCH.
Black Mountain, L. May, F. S.
Hendersonville, June, F. S.

FAMILY JASSIDAE
SUB-FAMILY ACOCEPHALINA

XESTOCEPHALUS PULICARIUS, VAN D.
Waynesville, 2500 to 3000 ft., Z. P. M.

Xestocephalus tessellatus, Van D.
N. C., Van D.
Balsam, 4000 to 5000 ft., Mid. Sept., Z. P. M.

SUB-FAMILY JASSINAE

Spangbergiella vulneratus, Uhl.
Raleigh, L. June to L. Aug., Z. P. M.

Parabolocratus flavidus, Sign.
Raleigh, L. June to E. Sept., Z. P. M.

Platymetopius cinereus, O. & B.
N. C., Z. P. M.

Platymetopius cuprescens, Osb.
N. C., Z. P. M.

Platymetopius acutus, Say.
Raleigh, L. May, F. S.
Hendersonville, June, F. S.
Waynesville (Rocky Knob), 4000 to 5000 ft., Mid. Sept., Z. P. M.
Balsam, 4000 to 5000 ft., Mid. Sept., Z. P. M.

Platymetopius frontalis, Van D.
Raleigh, L. June, F. S.
Andrews, Mid. May, F. S.

Platymetopius verecundus, Van D.
N. C., Z. P. M.

Eutettix subaenea, Van D.
Raleigh, Mid. Aug., Mid. Sept., E. Nov., Z. P. M.; E. July, F. S.
Swannanoa, Mid. July, Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., Z. P. M., 3500 to 4000 ft.

Eutettix seminuda, Say.
Raleigh, Mid. July, F. S.; Early July, Z. P. M.

Eutettix modesta, O. & B.
N. C., Fisk.

PHLEPSIUS SUPERBUS, VAN D.
N. C., Van D.

PHLEPSIUS EXCULTUS, UHL.
Raleigh, E. July, F. S.

PHLEPSIUS TRUNCATUS, VAN D.
N. C., Van D.

PHLEPSIUS IRRORATUS, SAY.
Raleigh, Early June, F. S.; Mid. July, F. S.; L. May, F. S.
Hendersonville, June, F. S.
Whiteville, L. July, R. S. W.

PHLEPSIUS FULVIDORSUM, FITCH.
N. C., Z. P. M.

ACINOPTERUS ACUMINATUS, VAN D.
N. C., Van D.
Raleigh, E. July to E. Nov., Z. P. M.
Stem, E. Oct., Z. P. M.

SCAPHOIDEUS SANCTUS, SAY.
Raleigh, E. Aug., C. L. M.

SCAPHOIDEUS AURONITENS, PROV.
Montreat, 2500 to 3000 ft., L. Sept., Z. P. M.
Balsam, 4500 to 5000 ft., Mid. Sept., Z. P. M.

SCAPOIDEUS JUCUNDUS, UHL.
Raleigh, Mid. Sept., Z. P. M.
Tryon, Fisk.

SCAPHOIDEUS CONSORS, UHL.
Tryon, Fisk.

SCAPHOIDEUS LOBATUS, VAN D.
Balsam, Mid. Sept., Z. P. M.

SCAPHOIDEUS PRODUCTUS, OSB.
Balsam, 4500-5000, Z. P. M.
Tryon, Fisk.

SCAPHOIDEUS CARINATUS, OSB.
Tryon, Fisk.
Black Mountain, Beutenmuller.

SCAPHOIDEUS NIGRICANS, OSB.
Raleigh, L. May, Z. P. M. (Type locality).

SCAPHOIDEUS IMMISTUS, SAY.
Raleigh, E. Aug., Z. P. M.
Waynesville (Rocky Knob), Mid. Sept., 3500 to 4000 ft., Z. P. M.

DELTOCEPHALUS REFLEXUS, O. & B.
Raleigh, L. June, Mid. Aug., Mid. Sept., E. Oct., E. Nov., Z. P. M.

DELTOCEPHALUS SAYI, FITCH.
Grandfather Mountain, Mid. Sept., about 5000 ft., Z. P. M.

DELTOCEPHALUS MINIMUS, O. & B.
Andrews, Mid. May, F. S.

DELTOCEPHALUS INIMICUS, SAY.
Raleigh, L. Aug., Z. P. M.
Blowing Rock, E. Sept., 3500 to 4000 ft., Z. P. M.
Grandfather Mountain, 4000 to 5000 ft., Mid. Sept., Z. P. M.
Balsam (Jones' Peak), about 4000 ft., Z. P. M.; 4000 to 5000 ft., Z. P. M.

DELTOCEPHALUS WEEDI, VAN D.
Raleigh, Mid. Sept., E. Oct., E. July, L. July, E. Oct., Z. P. M.; E. Sept., F. S.
Stem, E. Oct., Z. P. M.
Grandfather Mountain, about 5000 ft., Mid. Sept., Z. P. M.
Waynesville, E. Sept., Z. P. M.
Balsam, 4500 to 5000 ft., Mid. Sept., Z. P. M.

DELTOCEPHALUS COMPACTUS, OSB.
Raleigh, Mid. Sept., Z. P. M.

Deltocephalus flavocostatus, Van D.
Raleigh, L. June, E. Sept., F. S.
Balsam, about 4000 ft., Mid. Sept., Z. P. M.
Hendersonville, June, F. S.
Waynesville, Mid. Sept., 2500 to 3000 ft., Z. P .M.

Deltocephalus obtectus, O. & B.
Raleigh, L. June, F. S.; Mid. June to L. Aug., Z. P. M.

Deltocephalus perpunctatus, Van D.
N. C., F. S.

Deltocephalus areolatus, Ball.
Raleigh, Mid. Aug., E. Nov., Z. P. M.

Deltocephalus sylvestris, O. & B.
Raleigh, E. Nov., Z. P. M.
Andrews, Mid. May, F. S.

Deltocephalus nigrifrons, Forbes.
Raleigh, E. July to E. Nov., Z. P. M.
Grandfather Mountain, about 5000 ft., Mid. Sept., Z. P. M.
Balsam, 3500 to 5000 ft., Mid. Sept., Z. P. M.
Andrews, Mid. May, F. S.
Stem, E. Oct., Z. P. M.

Goniagnathus palmeri, Van D.
N. C., Van D.
Raleigh, E. Aug., C. L. M.; E. July, Z. P. M.

Athysanus exitiosus, Uhl.
Raleigh, Mid. Sept., L. July, Z. P. M.; E. July, L. March, F. S.
Waynesville (Rocky Knob), Mid. Sept., Z. P. M.
Statesville, April, F. S.
Hendersonville, June, F. S.
Stem, E. Oct., Z. P. M.
Balsam (Jones' Peak), about 4000 ft., Mid. Sept., Z. P. M.

ATHYSANUS CURTISII, FITCH.
Grandfather Mountain, 4000 ft., E. Sept., F. S.
Waynesville, 2500 to 3000 ft., Mid. Sept., Z. P. M.

ATHYSANUS BICOLOR, VAN D.
Raleigh, Mid. June, E. July, E. Sept., F. S.
Stem, E. Oct., Z. P. M.

ATHYSANUS OBTUTUS, VAN D.
Raleigh, E. Nov., Z. P. M.; Mid. April, F. S.; E. March, L. March, Z. P. M.
Statesville, Mid. April, F. S.
Balsam, 5000 to 5500 ft., Mid. Sept., Z. P. M.

THAMNOTETTIX CLITELLARIUS, SAY.
Raleigh, Mid. May, Z. P. M.
Balsam, Mid. Sept., 3500 to 4000 ft., Z. P. M.
Franklin, Mid. May., F. S.

THAMNOTETTIX KENNICOTTI, UHL.
Raleigh, E. Aug., C. L. M.; E. July, F. S.; L. July, E. Nov., Z. P. M.
Hendersonville, June, F. S.
Balsam, Mid. Sept., 4500 to 5000 ft., Z. P. M.

THAMNOTETTIX FITCHI, VAN D.
Hendersonville, June, F. S.
Jefferson, Mid. Aug., F. S.

THAMNOTETTIX BRITTONI, OSB.
N. C., Z. P. M.

CHLOROTETTIX VIRIDIA, VAN D.
N. C., Van D.
Raleigh, E. July to E. Nov., Z. P. M.
Stem, E. Oct., Z. P. M.
Balsam, Mid. Sept., about 4000 ft., Z. P. M.

CHLOROTETTIX GALBANATA, VAN D.
Raleigh, L. June, Z. P. M.
Waynesville, 2500 to 3000 ft., Mid. Sept.

Chlorotettix spatulata, O. & B.
Raleigh, Mid. Aug., Z. P. M.

Chlorotettix necopina, Van D.
Raleigh, E. July to Mid. Sept., Z. P. M.

Jassus olitorius, Say.
Raleigh, E. Aug. to E. Nov., Z. P. M.
Whiteville, July, R. S. W.
Highlands, E. Sept., R. S. W.
Andrews, Aug. F. S.,
Stem, E. Oct., Z. P. M.
Montreat, 2500 to 3000 ft., L. Sept., Z. P. M.
Grandfather Mountain, 5000 to 5500 ft., Mid. Sept., Z. P. M.
Lake Waccamaw, Mid. April, F. S.
Waynesville, Mid. Sept., about 3000 ft., Z. P. M.
Balsam, Mid. Sept., 4500 to 5000 ft., Z. P. M.
Balsam (Jones' Peak), 4500 to 5000 ft., Mid. Sept., Z. P. M.

Tinobregmus vittatus, Van D.
Beaufort, E. June, F. S.

Balclutha punctatus, Thumbg.
Blantyre, E. May, F. S.

Eugnathodus abdominalis, Van D.
N. C., F. S.

Cicadula 6-notata, Fall.
Raleigh, E. Aug., Z. P. M.
Hendersonville, June, F. S.
Blowing Rock, 3500 to 4000, E. Sept., Z. P. M.
Grandfather Mountain, about 5000 ft., Sept., Z. P. M.
Balsam, Mid. Sept., 3500 to 4000, Z. P. M.
Stem, E. Oct., Z. P. M.

Cicadula slossoni, Van D.
Balsam, Mid. Sept., 4500 to 5000, Z. P. M.
Hendersonville, June, F. S.

PARACOELIDIA TUBERCULATA, G. & B.
Raleigh, L. June, R. S. W.

DRIATURA ROBUSTA, O. & B.
Raleigh, E., L. July, E., Mid. and L. Aug., Z. P. M.; Mid. Aug., C. L. M.

DRIATURA GAMMAROIDEA, VAN D.
Raleigh, L. July, Mid. and L. Aug., Z. P. M.

SUB-FAMILY TYPHLOCYBINA

EMPOASCA VIRIDESCENS, WALSH.
Raleigh, E. Aug., Z. P. M.

EMPOASCA MALI, LE B.
Hendersonville, June, F. S.

EMPOASCA SPLENDIDA, GILL.
Hendersonville, June, F. S.

DICRANEURA ABNORMIS, WALSH.
Raleigh, L. March, Z. P. M.

DICRANEURA FIEBERI, LOW.
Raleigh, Mid. April, F. S.
Blantyre, E. May, F. S.

TYPHLOCYBA COMES, SAY.
Raleigh, Mid. Aug., F. S.; Mid. Sept., Z. P. M.

TYPHLOCYBA TRICINCTA, FITCH.
Raleigh, Mid. Sept., Z. P. M.

TYPHLOCYBA ILLINOIENSIS, GILL.
Southern Pines, Jan. and E. July, F. S.

THE SEASONAL DISTRIBUTION OF THE ARMY-WORM MOTH AT RALEIGH

BY C. S. BRIMLEY

During the summer of 1914 there was an outbreak of the army-worm (Leucania unipuncta) in North Carolina and at the suggestion of Mr. Franklin Sherman, our State entomologist, I kept a record of the number of moths of this species caught in a "sugar" baited moth trap which I run more or less every summer. The idea was to get some data as to the variation in numbers of the species, as well as to how late it flew in the fall and when it appeared again in the spring.

Before these observations my records simply showed that the moths of this species occurred at Raleigh from early May to late November without a break.

The observations were begun on August 13, 1914, and have continued till the present time (May 7, 1915), the moths all being caught in a modification of the old fashioned fly trap, but made larger and of curtain net instead of wire cloth. This trap is suspended from the limb of a tree and is baited usually with a mixture of molasses and water allowed to ferment and placed in a small tin bucket covered with net to prevent the moths drowning themselves in it.

I was not able to take time to count the moths on every night the trap was set and during the winter the trap was only set on warm nights when there was a likelihood of moths of some species being on the wing.

CATCH OF MOTHS

Date	Army-worm Moths	Other Moths	Per cent of Army-worm Moths
August 13, 1914	61	21	75
August 14, 1914	53	11	84
August 15, 1914	27	10	73
August 16, 1914	74	29	71
August 17, 1914	77	25	75
August 19, 1914	15	7	68

Date	Army-worm Moths	Other Moths	Per cent of Army-worm Moths
August 20, 1914	153	18	89
September 4, 1914	35	19	64
September 19, 1914	3	7	30
September 21, 1914	7	15	33
September 22, 1914	55	46	54
September 23, 1914	36	49	42
September 28, 1914	7	19	27
September 29, 1914	15	7	68
September 30, 1914	13	30	30
October 1, 1914	14	14	50
October 8, 1914	27	10	73
October 26, 1914	3	1	75
October 30, 1914	7	0	100
October 31, 1914	4	0	100
November 3, 1914	4	0	100
November 4, 1914	11	1	92
November 5, 1914	22	5	81
November 7, 1914	6	0	100
November 8, 1914	9	3	75
November 9, 1914	26	2	93
November 12, 1914	1	0	100
November 14, 1914	3	0	100
November 16, 1914	10	5	67
November 26, 1914	1	1	50
November 27, 1914	7	0	100
November 28, 1914	4	0	100
November 29, 1914	3	0	100
November 30, 1914	7	0	100
December 2, 1914	38	2	95
December 3, 1914	24	1	96
December 4, 1914	53	2	96
December 5, 1914	17	1	94
December 22, 1914	1	0	100
April 17, 1915	1	1	50
April 19, 1915	1	0	100
April 20, 1915	4	7	36
May 3, 1915	1	8	11
May 5, 1915	2	9	18
May 6, 1915	1	3	25

REMARKS ON ABOVE TABLE

August 19, added fruit juice and a little molasses to bait. About as many in trap on August 21 and 28 as on August 20

and about same proportion of army-worm moths. About 50 arm-worm moths in trap on September 6, and about 20 to 25 during following week, then numbers decidedly decreased. Several inches of snow fell on night of November 19, following a killing frost on November 17, which killed all remaining susceptible vegetation, weather continued comparatively cold till November 25. Between Demeber 5 and 22 the weather was either wet or cold, the minimum temperature dropping as low as 16 or 17 for two or three days. From December 23 to April 16 inclusive the trap was set nine times, catching 22 moths, including 1 cutworm moth, but no army-worm moths. Between April 21 and May 2 inclusive, the trap was set eight times, catching 43 moths, including 11 cutworms moths (Agrotis ypsilon and Peridroma saucia) but no army-worm moths. On May 4, eight other moths were caught.

The army-worm moths caught in April and May have with one or two exceptions been very evidently worn specimens.

Raleigh, N. C.

VOL. XXXI NOVEMBER, 1915 No. 2

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OF THE

ELISHA MITCHELL SCIENTIFIC SOCIETY

ISSUED QUARTERLY

CHAPEL HILL, N. C., U. S. A.

TO BE ENTERED AT THE POSTOFFICE AS SECOND-CLASS MATTER

Elisha Mitchell Scientific Society

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VOLUME XXXI NOVEMBER, 1915 No. 2

COÖPERATION IN MATTERS CHEMICAL[1] PRESIDENTIAL ADDRESS

BY CHARLES HOLMES HERTY

The expressive and recently much quoted phrase, "Don't rock the boat," is an injunction promotive of safety, but the closely related "Pull together," of common parlance, suggests the method of effective advance. In the hope, therefore, of aiding somewhat that line of progress in which we feel particular interest and for which we are largely responsible, I have chosen as a subject for this occasion, "Coöperation in Matters Chemical."

Its treatment must necessarily be purely national, for the international aspects have been eliminated by the embitterments of the European struggle. Just three years ago there met together in New York City, on the occasion of the Eighth International Congress of Applied Chemistry, representatives of all the leading nations of the world for report and conference on subjects pertaining to the advance of that science whose interests call us together now. The key-note of that meeting was, "Science knows no geographical boundaries," and plans were enthusiastically formulated for future coöperative effort.

Alas, how unexpectedly, how grievously and how completely that key-note has been forgotten, those plans set aside, amid the strife and turmoil of war. The words "forgotten" and "set aside" are used advisedly, for that key-note is eternal

[1] Reprinted from the Journal of the American Chemical Society, Vol. XXXVII, No. 10. October, 1915. Presidential address, Fifty-first Meeting of the American Chemical Society, Seattle, August 31 to September 3, 1915.

verity, and men of all nations must work together if the greatest progress is to be realized. The unfortunate recriminations of men of science, so widely heralded in recent months, will eventually be replaced by those nobler feelings of brotherhood which lie deep in the hearts of all whose life-work has been the search for truth.

Meanwhile, chemistry is suffering a staggering blow; the call for men in European armies has almost depopulated university laboratories, the gripping realities of war have absorbed the thought and interest of many of the leaders of our science, and the shrinkage of many chemical journals, as already evidenced in our own "Chemical Abstracts," bears abundant witness to the lean years that are just before us. That this sterility of production is to be extended far beyond the actual duration of the war period is emphasized by the ages of the men who constitute the bulk of the armies. The loss of such young men, the leaders of the next generation, casts its shadow before.

How does this situation affect us here where the curse of war has not fallen? Surely we would be false to our science, to ourselves and to humanity if we did not strive with redoubled effort to make good this present and oncoming deficiency so far as in our power lies.

It would be a work of supererogation for me to make any plea for research or to attempt its justification before the members of the American Chemical Society; for this organization embraces within its now more than seven thousand members that great body of men whose tireless efforts have within the last two decades so richly increased chemical literature, and the publications of this society show annually increased volume in the preservation and dissemination of the records of such research. The ever-present struggle between the makers of the budget and the pressing claims of the editors of our journals is sufficient proof of the rapid growth of research in America. Happily the day has passed when our chemists felt the need of publication in foreign journals to insure wide hearing. All honor to the men who early de-

termined that America should have publications worthy of the name and who consistently gave their loyal support to this great undertaking!

The aim of research is the discovery of truth. On this point all are agreed. But why such an aim? "Truth for Truth's sake," "Science for Science's sake," and similar familiar phrases have no meaning to me. I can find only one answer to this question—the uplift of humanity. In the engrossing interest of research problems, however, we sometimes adopt an artificial division of scientific research into "pure" and "applied," the former term uttered sometimes by university men in a tone of snobbishness, the latter occasionally by men of the technical laboratories with a rather disdainful regard of obligations to the science on which their operations are based.

I think of research in chemistry as a field whose highest fruition calls for two kinds of service. On the one hand the constant enrichment of the soil, "pure chemistry," if you will, and on the other the seeding, tending and harvesting, "applied chemistry;" each absolutely essential, and incapable of its highest fulfillment without the other, using the same methods, demanding identical care, skill, accuracy and thoroughness, and working toward the same end—the uplift of humanity. If this be not the mutual goal, then pure chemistry becomes a selfish toy and applied chemistry a mere tool for greed. In both lines of service the hearty coöperation of all chemists is needed.

The continued use of the terms "pure" and "applied" in what follows involves, therefore, no question of relative dignity or scientific justification, but is based simply on that privilege of convenience which we reserve to ourselves in continuing the use of the terms "organic" and "inorganic" chemistry.

For training in the ideals and methods of chemical research we rightly look to our universities, and if the ideal of research include both "pure" and "applied," then must the universities set forth that ideal both in word and act. Its

formal statement, accompanied by discriminating favor toward the one or the other in the actual lines of work pursued, does not meet that full responsibility which every university bears to chemical research.

And this brings the responsibility to the individual laboratory head, for in his own department he represents his university. Whatever his ideal, rest assured it makes its full imprint on those working under him. The joint planning of work, the daily informal conference in the laboratory and mutual presence at the dawn of new truth create naturally in the student a strong bond of sympathy and loyal regard. Ideals are unconsciously absorbed. Thus there are sent forth each year from the laboratories young men impressed with the ideals of the men in charge, and thus is the national viewpoint in such matters largely determined. I speak now of the average American university, fully conscious of the necessity of differentiation of work in the staffs of the larger institutions and equally conscious of the difficulties under which men in the smaller institutions often work. But the ideal holds for one and all alike.

The claims of research in pure chemistry in our universities need no urging on my part. The opportunities and inducements for such work already abundantly exist. It is gratifying to note the change of popular sentiment toward such work. The old question "Of what use?" is gradually being replaced by a sound conception of the fundamental function of the science of chemistry and by a recognition that the advancement of this science is not effected by inspiration, but by the contributions of many zealous, patient and enthusiastic workers. By slow process of accumulation the data are supplied for new generalizations which bring us gradually nearer and nearer full truth.

The record in the Journal of this Society shows a steadily increasing output of such work from university laboratories. That the amount of this work will increase is a hope and a belief fully justified by the attitude of university authorities

in providing better laboratory and library facilities and more fellowships for graduate students.

In connection with the subject of university research in pure chemistry, may I be permitted a word concerning a special class—the men in charge of laboratories in smaller institutions of learning. Fresh from doctorate training, they enter upon the new responsibilities filled with zeal and a fine fire for continuation of research. After a period of adjustment to normal duties of the new environment and with thoughts turned to independent research there comes the realization of the poverty of equipment both in laboratory and in library facilities as compared with former surroundings. Then comes a period of earnest effort to better this equipment, only to find how many other undeniable demands are being made on the very limited institutional funds. There follows a period of depression and discouragement, and then—how often that worker is lost to the cause of pure chemistry!

But is the situation really as bad as it sometimes seems? Many of the most valuable researches in the literature have been conducted on inexpensive material and often under most discouraging circumstances. If money is lacking, there are endowment funds to aid research, and, to supplement inadequate library facilities, there is the splendid library service of the United Engineering Society of New York City. By such means it may still be possible to follow that first fine impulse.

The great danger to research in pure chemistry in America at the present time lies in the mental distraction and demoralization resulting from engrossing consideration of daily developments of the European war. The mammoth scale and startling disclosures of that fearful struggle as depicted in the morning, evening and ever appearing "extra" newspapers challenge our constant attention and fill us with the horrors of the situation. Is it right that we give way to this demoralization and thus increase the disastrous effects of such abnormal times?

Chemistry, perhaps more than any other branch of science, has received wide advertisement in connection with the present war. Many to whom it was formerly little more than a name, have within the past year done it homage; but such glorification has emphasized the application of chemistry rather than the broad, deep foundation which has been so quietly laid by the workers in university laboratories during the years that have passed. Pressure for industrial application of chemistry along very restricted lines is great at present. The public is willing to listen and capital ready to invest. It seems fitting, therefore, that at this moment emphasis be laid on the basic science which underlies these applications. It seeks no advertisement and often in disjointed form receives but scant recognition, but it is the soil from which the fruitage must spring. To the maximum development of that soil all chemists, at least to some degree, are pledged and bounden. I do not hesitate, in a plea for coöperation, to urge that in all industrial research laboratories, ranging from those of the large corporations, splendidly manned and equipped, to those of the youngest analytical chemists, there be carried on some line of research which has no special client, for which no fee is expected, but whose function is to repay in some slight degree the debt that every chemist owes to the science of chemistry. The subjective influence of such work would far more than compensate for the time spent in its execution.

The ideal of research which I am urging includes both pure and applied chemistry. Since it is the function of universities to give the younger generation, chiefly through research, that training which will equip them for trustworthy, intelligent and broad-minded independent effort, should not our universities provide investigations in the field of applied as well as pure chemistry? The carrying out of successful work in this field involves thorough search of the literature, preliminary tests, systematic experiments, carefully drawn conclusions and preparation of the work for publication. These are the normal proceedings in all research work.

Furthermore, it must be remembered that a majority of those being trained in university laboratories are looking forward to entering various industries. This is to be expected, for ours is a country in the midst of a great industrial development. We have passed through the pioneer days when the conquering of a new land, the struggle for habilitation, was supreme; so, too, has the fight for liberty of thought and action been won; and just a half century ago, in that bitter fratricidal strife, was established once and for all the fact that this is a united country. With the recovery from the wastage of that war industrial development came into its own. Manufacturers are no longer characteristic of any one section, but, as labor becomes trained, are spreading rapidly over the whole land. Capital is constantly increasing and seeking profitable channels of investment.

It is important to us that the manufacturer is rapidly becoming convinced that the work of the chemist results in the substitution in industries of scientific foundation for gross empiricism, of accurate knowledge for approximate guesswork, and of lines of attempted advance based upon the results of research for the hit-or-miss method. This conviction was greatly strengthened by the address of President Little before this Society in 1913, on the subject of "Industrial Research in America."

Another call for the chemist in industry has arisen from the propaganda for conservation of our natural resources. President Bogert, in his 1908 address, pointed out clearly the important role the chemist must play in this great undertaking.

In view of the consequent increasing demand for chemists and of the relatively small number of highly trained men from our laboratories, is it small wonder that so many of our university students are looking forward to entering industrial chemistry as a profession?

In advocating a more general pursuance of research in applied chemistry in university laboratories, I do not feel that the prerogatives of the commercial industrial research labo-

ratories of the country would be encroached upon. The field is so large and the problems awaiting solution are so manifold that the entire chemical strength of the country is insufficient to give these problems that consideration which would bring our industries promptly to the state of efficiency which can be reached only by the aid of the chemist. In the conservation and better utilization of natural resources lie sufficient problems to furnish subjects for theses in all our university laboratories.

The term "university research," however, has a broader meaning than the selection of a topic for a thesis and the systematic experimentation connected therewith. In its widest significance it is the embodiment of the university spirit itself. It typifies the relation of each university to its environment. Surely no institution can afford to be unheededful of that obligation. In its entirety it summarizes university attitude toward the complete life of the nation.

We would do well, therefore, to give serious consideration to the question often asked during the past year in a comparative way, "Is there adequate coöperation between our universities and our industries?"

I do not feel competent to attempt to answer that question categorically. Certain it is that coöperation implies the acts of at least two parties, and the question therefore directs itself with equal force to universities and to industries. Equally sure is the conviction that such coöperation would inure to the benefit of each.

For five years I was closely associated with successful business men. From that broadening experience I brought back to university surroundings no clearer impression of those men, both individually and in common council, than their desire to know the truth concerning any proposition before them, for with such knowledge they could wisely plan for the future. Desire for publication of that truth may not be so pronounced with them as with us of the universities, but the unflinching attitude towards facts, as revealing truth, is com-

mon to both classes and therein lies a strong bond of sympathy and basis of coöperation.

If that coöperation is not complete, how can the situation be improved? May I be permitted here to make a few suggestions, or rather, let me ask a few questions?

Speaking to the men of the universities I would ask:

First, of each individual head of a university chemical laboratory: What is your personal conception of the relation of your laboratory to industrial life? Do you feel that the problems in this field are fully worthy of your time and tireless thought? Do you find inspiration in the hope that your work may result directly in the transformation of some crude or now worthless natural product into a form of higher value to all, or that waste in some of its many forms shall be diminished, or that forces now acting disjointly may be so correlated that new blessings for mankind may result?

If such questions find ready affirmative, the spirit of coöperation is abroad and must make itself felt.

Second: Do we have the men of the industries often enough before our university classes?

I do not mean for the purpose of delivering formal lecttures, knowing full well their aversion to the preparation and delivery of such; but surely each of these men has in his every-day life abundant experience and difficulties, the presentation of which would give sounder conceptions, broader understanding, and more intelligent grasp of conditions to be met in the work-a-day world ahead.

Third: Are we sure that we give our lectures on industrial chemistry, especially to undergraduates, from the best point of view?

A recent experience may be worth recording here. For several years I followed the lines usually adopted in standard texts, but the division into inorganic and organic technology seemed artificial, in view of the preachments on that subject during the previous course in general chemistry; the usual grouping of topics seemed to be very loosely connected; in fact, the course lacked unity of

purpose and sound pedagogical basis. I finally determined to change the whole point of view, and gave a series of lectures on "staple crops and natural resources as affected by industrial chemistry." For illustration, and without going into detail, the cotton crop was discussed: its demands on the fertilizer industry, following the fiber through its changes by bleaching, mercerization, mordanting, dyeing, printing, nitration, etc.; then following the seed through the mill and the conversion of the hulls into feed and paper, the use of the meal as feedstuff, the refining of the oil, its hydrogenation, the utilization in the soap industry of the waste in refining, the recovery of the glycerine and its nitration. In this way all the subjects treated in former years are covered, but in an entirely different order. The predominating thought is chemistry in the service of mankind. New conceptions are obtained of material blessings, of inter-relations of industries, of utilization of by-products, of advances already made and of promising lines of further advance. At the end of the year there is complete picture in the student's mind, an awakened interest in his material surroundings, a true comprehension of the part chemistry has played in this industrial development, and, in many cases, a determination formed to joint the ranks of chemists in carrying forward this development. The results already obtained from such a treatment of industrial chemistry abundantly justify the change.

Speaking to the men of the industries I would ask:

First: Is not your interest in our universities very remote, if indeed it exists at all?

Yet in them are being trained young men whom, in constantly increasing numbers, you will call to your aid to promote the efficiency of your operations and thus enable you to meet the keener competition of the future; in their libraries is a technical literature which will put you in immediate touch with the latest developments in fields of direct interest and importance to you; and on their staffs of instruction are men trained to think accurately, to investigate skillfully, and

with whom frank discussion would often lead to valued connections.

Second: Is a visit to your plant by an instructor and his group of students simply a thing to be endured or gotten through with as rapidly as possible by the aid of some subaltern who lacks your knowledge of the larger aspects of the industry in which you are engaged?

Such occasions could be made of inestimable value in cultivating true coöperation between industries and universities.

Third: Would it not be possible to include university men more frequently on the programs of industrial conventions?

Such a policy would be a mutual help, stimulating thought and breeding good-will.

Fourth: Have you aided our universities in a material way?

Coöperation is mutual helpfulness. Many of the fundamental principles of present-day industries have been worked out in university laboratories. You can aid in many ways; by furnishing material prepared under factory conditions for use in research in university laboratories, by contributing equipment which will widen the possibilities of such work, by enlarging department libraries which constitute the prime prerequisite of all research laboratories, and by endowing fellowships which will enable many a promising young man, otherwise unable, to continue his work through that unremunerative period of higher training which is requisite if he is to realize his highest possibilities.

I know of no more fitting illustration of the spirit of coöperation in matters chemical than the organization and wise general policies of this Society. In its large and constantly growing membership are included the university men and those directly connected with the industries. By joint effort and with increasing enthusiasm an organization has been developed which is daily increasing in value as a national asset.

Its general meetings, stimulating interest in chemistry in whatsoever section of the country held, are participated in by both classes of chemists, and the healthy, broadening influence of this contact is appreciated by each alike.

Its three splendid journals are placed in the hands of every member. While the subject matter of these journals is differentiated, it is rightly assumed that each is of importance to every member and the three as a whole thus furnish the greatest of all influences in the development of chemistry in our country.

Rapid growth in membership and increased productivity in research rendering impossible the completion of programs at general meetings, divisions were organized under the administration of President Bogert. Reasonable opportunity is thus afforded for such specialization as may be desired, but membership in these divisions is open to all and attendance is composite.

Occasionally a note is heard that we should divide into two separate organizations, the university men in one and those of the industries in another. Happily that note finds no response of any general character and I sincerely hope it never will.

For the sake of the future let me point out one of the best features of our organization, and yet one which holds within itself the gravest danger if the spirit of coöperation be not all-pervasive. I refer to our Local Sections. With a membership distributed over such a wide area and with only two general meetings of the Society held each year, such local sections furnish to many almost the sole opporunity for fraternal association, for discussion of matters of somewhat restricted interest, for bearing the expense of invited lecturers and for placing before the Council the views of the respective sections on matters of general policy of the Society. These are some of the strong points of this feature. The danger lies in local-sectionalism, which magnifies the part at the expense of the whole, which in the effort to advance locally is forget ful of the common good. The danger is insidious and often

clothes itself in the guise of the broader sentiment, but it is all the more grave for this reason. Let us hold fast to all the elements of strength in our local section system and see to it that only good flows therefrom to the parent organization.

Another and novel form of coöperation in matters chemical has recently manifested itself in the form of an invitation from the Secretary of the Navy to our Society to nominate two of its members to serve, with representatives of other scientific societies, on the proposed Naval Advisory Board. I am sure you will approve my prompt acceptance, in your behalf, of this invitation. To secure the nominations promptly and in the spirit in which the invitation was given, the Council was asked to make these nominations as it is closely in touch with the full membership of the Society through the local sections. The result of the letter-ballot has been communicated to the Secretary of the Navy and will be announced by him.

That the spirit of coöperation is beginning to make itself felt is evidenced by the joint participation of the chemical manufacturers in this country and of the government bureaus in the first National Exposition of Chemical Industries to be held this month in New York City. This assemblage has in it great potentialities which, if realized, may have far-reaching influence in the rapid promotion of hitherto undeveloped lines of chemical industry.

In conclusion, let me discuss with you one other phase of coöperation, namely, that between the American people, through their representatives in Congress, and our chemical industries. I have no leanings toward paternalism, and I believe in the doctrine that a good, stiff struggle for existence is conducive to longevity, but there are certain normal functions of our national Congress which make or mar industrial development, and there are certain undertakings in behalf of the nation as a whole which individuals can not be asked nor expected to assume.

Recent events compel the conviction that the assumption of our peaceful world relations, which formed the basis of

my earlier plea, may be at any moment completely shattered. In such an event the responsibility of all chemists in this country will be added to by the impelling call of patriotism. That the contributions of our science are of the highest value in modern warfare is daily attested in the reportorial accounts of the new developments among the now contending nations. Who would dare say that the innovations of chemistry in the methods of warfare have reached a limit?

In view of this recognized fundamental importance would it not be well, in these days of talk of preparedness, to consider the question of chemical preparedness. Ships, guns and shells are necessary, yes, but most largely as a means to an end, and that end the effecting of a violent chemical reaction at a point more or less distant. Naturally in matters of preparedness there are topics whose public discussion is inadvisable, but there is one to which I do not hesitate to allude, for the facts are all matters of published record, and that is the question of the visible supply of sodium nitrate in this country.

In these days of rapidly shifting international relations the only sound and rational policy is national self-containedness. Blessed with a rich heritage of wonderful and varied natural resources, and, in our isolation, confident of freedom from grave international complications, we have received potash supplies from Germany with but scant forethought, save in the national Bureau of Soils; and now, today, agriculture is seriously threatened; so, too, textile manufacturers, reaping a bountiful harvest from the laboratories and dyestuff factories of Germany, have given no helping hand to the struggling young home industry which with a fair show would now have been able to meet the present serious deficiencies. Of far greater importance, at least from the standpoint of preparedness for war, is the fact that at present we are dependent solely on Chili for supplies of sodium nitrate, the crude material for nitric acid, that *sine qua non* in the manufacture of all modern explosives, whether guncotton, trinitrotoluene, picric acid, fulminating mercury or what not.

True, the work of the chemist has shown in later years how to prepare this substance from the nitrogen of the air, but such processes have not been able to compete commercially in this country with its manufacture from sodium nitrate and sulfuric acid. Equally true, we now see no immediate probability of any shutting off of the supply of nitrate from Chili; in the question of preparedness for war, however, probability has no place where certainty can be assured.

It would seem the part of wisdom, therefore, to accumulate, through governmental aid or agency, sufficient extra supplies of sodium nitrate to assure, in case of war, maximum activity of explosive manufactories until sufficient plants could be erected for the adequate manufacture of nitric acid from the air. The annual importation of this material averages 550,000 tons, which represents an investment of approximately fifteen million dollars. The presence of an extra year's supply within our borders might prove of inestimable value. If, happily, the war cloud passes, such accumulations of nitrate would then be gradually absorbed in the more peaceful lines of the fertilizer industry, and the cost of such preparedness be thus limited to the expense of storage and the interest on the funds invested.

The phrase "chemical preparedness" refers really to the whole question of the status of chemical industry. Have we so grappled with the many questions of material national life that we can await future political developments with quiet confidence and utmost faith? Undoubtedly much has been accomplished, but this is no time for self-congratulation. Far more profitable will it be to look shortcomings squarely in the face, to trace influences which have retarded progress and to endeavor in every legitimate way to overcome such influences. Time does not admit of too extensive treatment of this subject, but there are two matters whose present importance justify further discussion. I refer to the patent system and to our tariff legislation.

The apparently authentic statement that more money is spent in this country to secure and defend patents than is

earned from all those issued seems a sad commentary either on the morals of the nation or on the efficiency of the patent system. With a natural unwillingness to admit the first alternative we are forced then to ask wherein lies the deficiency of the patent system?

Primarily, and of greatest importance, is the failure of our people as a whole to understand the purpose of a patent system and its value as a national asset. Its purpose is to foster a creative spirit throughout our citizenry by giving to intellectual rights that legal protection in ownership which is afforded property rights, such ownership carrying with it the right to profit therefrom. He who creates is entitled to remuneration, for by his originality he places the nation in his debt. Such indebtedness is no hardship, for the patentee takes nothing away, but makes his entry in advance on the credit side of the national ledger. That such entries may represent maximum creative ability, it is essential that they be made in an atmosphere of good-will and in full confidence of due and prompt guardianship of the account.

Too often the attitude of the public is one of antagonism to the patentee, and too often manufacturers, pursuing a short-sighted policy, endeavor in every way to evade his legally conferred rights. Is it a worthy thought on the part of "business," that, since inventive genius so often lacks business qualifications, it offers a fair field for commercial piracy? Let us shake off such thoughts and by coöperation seek to promote that creative spirit, the fostering of which lay in the minds of those who founded the patent system.

The value of the patent system as a national asset lies not only in the constant additions to daily welfare, but also in the eventual public ownership of the new ideas underlying these contributions, for the life of a patent is only seventeen years, during which time expenditure both of brain and of funds is necessary to bring the idea to its highest practical development; then the idea legally becomes the property of the nation for unrestrained use. Are we willing that this national asset should be depreciated by an unending tax on

the time, thought and finances of composite American genius?

If these general considerations ever find full lodgment in the public mind, there will be no difficulty in securing such congressional action as will perfect the patent system and legal procedures incident thereto, thus enabling it to serve fully those high ends for which it was designed.

Finally, in the light of the present situation, may we not hope for more generous coöperation between Congress and our chemical industries in solving those innate economic difficulties whose temporary correction can be provided for only through adequate tariff legislation? I realize fully that the trend of national opinion in recent years has been toward a lowering of tariffs, in the conviction that industrial giants were parading in the guise of swaddling clothes, but the present unforeseeable situation, resulting in the cessation of imports from the chemical industries of Germany, has shown to all several strikingly weak links in our industrial chain. We can not afford such. "National self-containedness" is a more fitting slogan for us now than "Tariff for revenue only." If such links are to be strengthened, we must, as a people, meet the expense by giving for a reasonable time that measure of protection which will effect a union of capital and scientific skill under no undue stress of unfair foreign interference.

No other phase of our chemical industry illustrates so well the point in mind as the synthetic dyestuff industry about which so much discussion has turned during the past year and concerning which even more active discussion is destined to be furnished during the year just ahead of us. Although the clamor over the shortage of synthetic dyestuffs in the early period of the present war was shown by undeniable statistics to have had no basis in fact, nevertheless the present complete cessation of shipments from Germany and the constant inroads on the stocks in hand have now brought about a real and serious shortage.

True, the total annual value of our needs in this line, some fourteen or fifteen million dollars, including duties

paid, is not large as compared with the volume of many other industries, yet the use of the products is so ramified throughout industrial life, reaching in some way so many manufacturing plants and threatening to affect so many laborers that the question naturally finds anxious utterance—"What can we do about this shortage?" This question can be answered best by an unflinching facing of what we as a people have done, and, equally important, what we have not done.

The synthetic dyestuff industry stands today as Germany's triumph. It has been developed partly by that hearty coöperation of industries and universities to which I have already referred, and partly by favorable legislation. It is permeated in every branch by the spirit of research. In its interlacing character it is bound together by reasonable, common-sense coöperation, and it is long past the experimental stage with these attendant heavy financial losses.

At one time we had a young industry, nine factories in all. It is interesting to note that during the decade 1872-1882, with a tariff of 50 cents per pound and 35 per cent *ad valorem* then in force, the price of "aniline red," the principal dye then in use, was reduced from $6.50 to $2.25 per pound. With the lowering of the tariff on dyestuffs in 1883, five of the factories ceased operations. I am not arguing the wisdom of such legislation, but am simply stating facts. Further, it is a matter of public record that the most earnest advocates of tariff reduction on dyestuffs and opponents of its increase were those who are now rightly so alarmed about the present shortage. Again I do not criticize, but state facts in explanation.

In spite of these difficulties one of our factories successfully undertook at one time a considerable production of aniline oil and other intermediate products for which we had depended, up to that time, on foreign countries. What was the result? A market flooded with these products from abroad at prices far below American cost of production. Why? For the express purpose of throttling the new effort in this country, the quintessence of "dumping."

What could be done in such a situation? What can be done today in any similar situation? It is a task too great for economic enterprise and there is no legal redress. In our intra-national conduct of business we have, by effective national legislation, put the stamp of public condemnation on this practice of dumping, and have insisted that in business relations with each other the spirit of true democracy must reign, granting to each full opportunity to develop to that maximum to which talents and energy enable and entitle. I badly misjudge the temper of our people and their spirit of fair play, which is the essence of democracy, if, given opportunity to understand this situation, they do not speedily set about to correct, through their representatives in Congress, this serious defect in national legislation by the enactment of an effective "anti-dumping" clause.

To meet the present deficiency in dyestuffs some progress has been made. Naturally the use of vegetable dyes, at one time our sole dependence, has materially increased. One synthetic dyestuff factory has felt justified, through the agency of long term contracts at trebled prices with its customers, in undertaking the manufacture of those "intermediates" necessary in the manufacture of its specialty. The extremely high prices at present ruling have stimulated the organization of a few more manufacturing concerns. The Department of Commerce is seeking to aid in many ways. The outlook for raw material has improved through the realization of its waste in the beehive coke ovens, though most of the increased recovery is at present finding its way into the manufacture of explosives. After all is said, however, the serious deficiency still exists and will continue unless the day of peace be inconceivably near, or prompt and effective measures be taken.

It may seem strange that, with an intense demand for its products, an assured supply of raw material, and an abundant supply of technically trained chemists, the American dyestuff industry shows as yet no evidence of that full expansion which will enable it to meet the present crisis and

provide in the future for our constantly growing needs. The explanation is simple: capital is not convinced that investment in such an industry, under present conditions, is profitable or safe—and rightly not convinced, because the opinions of experts, familiar with every phase of this industry in Germany and in America, agree that under present tariffs it would be unprofitable, and past experience with German practice justifies the fear of inordinate dumping, which will take place in the inevitable struggle to regain markets, following the return of peace.

The prime consideration, therefore, in the immediate development of this industry in our midst, is congressional action in the form of an effective anti-dumping clause and an increase, for a reasonable period, of the present tariff on dyestuffs. As a guide to what this increase should be, we have the judgment of the committee of the New York Section of this Society, a committee representative of all interests concerned, in the persons of: B. C. Hesse, chemical expert in coal-tar dyes, *Chairman;* H. A. Metz, for the importers; J. B. F. Herreshoff, for the manufacturers of heavy chemicals; I. F. Stone, for the American coal-tar dye producers; J. Merritt Matthews, for the textile interests; David W. Jayne, for the producers of crude coal-tar products; and Allen Rogers, Chairman of the New York Section. The unanimous report of this committee, which was unanimously adopted by the Section, says: "It has been conclusively demonstrated during the past thirty years that the present tariff rate of 30 per cent on dyestuffs is not sufficient to induce the domestic dyestuff industry to expand at a rate comparable with the consumption of dyestuffs in this country and that, therefore, all dyestuffs made from coal tar, whether they be aniline dyes or alizarin, or alizarin dyes, or anthracene dyes or indigo, so long as they are made in whole or in part from products of or obtainable from coal tar, should all be assessed alike, namely, 30 per cent *ad valorem* plus 7½ cents per pound specific, and that all manufactured products of or obtainable from coal tar, themselves not dyes or colors and

not medicinal, should be taxed 15 per cent *ad valorem* and 3¾ cents per pound specific."

Are the people of this country ready to coöperate with the chemists by authorizing the prompt enactment of such legislation? If so, there need be no fear that active capital will be longer withheld, and thus we can feel confident of a synthetic dyestuff industry commensurate with our needs.

As I think of the possibility of such an industry, I recall the words of the Swiss professor, Gnehm, who, in 1900, after one of his lectures on coal-tar dyes, said to me: "The natural home of the dyestuff industry is in your country and some day it will flourish there."

The creation of such a self-contained industry, however, has far deeper meaning for our national welfare than the supplying of needed dyestuffs, for such plants would constitute an easily convertible reserve for the manufacture of coal-tar explosives in times of war.

Through its stimulative effect on research, on technique and in supply of material the dyestuff industry has furthered the development of both the explosives and the medicinal industries. Its firm establishment here would foretell the complete development of each of this great trio of industries, which, as a whole, furnish the rational and economic utilization of that great mass of coal tar which now wastes itself in useless flames above the coke ovens throughout the land.

Coöperation—it is a good word, and carries with it a wonderful power of accomplishment!

Chapel Hill, N. C.

THE MERIT SYSTEM IN HIGHWAY WORK[1]

BY JOSEPH HYDE PRATT

In opening this discussion on the subject, "The Merit System in Highway Work," I am doing so without any reference to the paper of Mr. Dana, as I have had no opportunity of reading it.

At first glance we are apt to think of this subject as applying simply to "civil service" appointments and the inauguration in a state of the civil service method of governing all appointments. I am not, however, considering the subject from this standpoint.

I am thoroughly convinced that a "merit system" can very profitably be made applicable to highway work in any state and in such a manner that it will permeate the whole road organization, from the highest official to the cheapest laborer.

There are certain fundamental principles, however, relating to road construction and maintenance, that must be recognized by the people of a state before any satisfactory results can be obtained:

1. That the construction and maintenance of public roads must be considered as a purely business proposition.

2. That satisfactory results can only be obtained by having experienced men in charge of the work.

3. That the road work can not be used as a political football, and the road forces used as a medium for paying political debts and, at the same time, the people get a satisfactory expenditure of their money and a good system of roads.

It may be, that in my treatment of this subject, I shall seem to depart somewhat widely from it and to discuss certain subjects that have been assigned to others, but in doing so, it is only to be able to emphasize more fully, certain points of my own subject that I wish to bring out.

[1] Read before the Pan-American Road Congress, Oakland, Cal., Sept., 1915.

As a business proposition, it seems to me that it is necessary that we should consider our subject applicable to the very beginning of a road organization, namely the members of the "Highway Commission."

This commission should, so far as possible, be non-political and made of men who are interested in the road work of their state, and so appointed that only a certain percentage of their number shall retire at one time, and this commission shall have a similar relation to the highway work that a board of directors has to the work of their corporation. In some states the members of the highway commission are appointed directly by the governor of the State and represent the state at large,—in others they have to be appointed from certain districts of the state so that each section of the state will be represented in the commission. Members of the commission are sometimes designated by the General Assembly of a state. In certain instances they are members of the Council of State; in others they are professors of civil engineering of the state university and colleges; and in some states it is a combination of both. In several states the personnel of the commission is so regulated that at least a certain percentage must be of the minority political party of that state. These varied methods of forming a highway commission have been brought about, undoubtedly, by the people beginning to realize that their highway commission must be appointed or made up in the interest of the highway work of their state. As the people realize the necessity of this and demand it, they can and will get the kind of a commission they want.

LENGTH OF SERVICE

To this commission should be given the authority of the employment of the State Highway Engineer or State Highway Commissioner, for, with a commission as outlined above, much better results will be obtained by its appointment of the engineer, than if he is appointed by a Governor, whose term of office may be only two years. To the Commission should also be given the authority to designate the

salary of the State Highway Engineer or State Highway Commissioner and all other employees. With this authority, the commission is in a position to obtain the services of an engineer who is in every way qualified to fill the position, and he must be a man of wide experience in highway work and also have executive ability. I believe that such a commission as I have mentioned, will appoint the State Engineer on account of merit and not for political reasons; for worth and not for favoritism.

The value of such an engineer to the state obtaining his services, rapidly increases with the length of service and, therefore, it is to the material advantage of the state to retain the services of such a man, and the engineer must have some assurance that the character of his work will determine his length of service.

When the engineer is appointed by the governor there is very apt to be a change of engineers with change of governor, particularly if there is a political party change at the same time. With the appointment by a commission, as outlined above, there is but little chance of change of state engineer even with change of political party. Many state universities are governed by boards of trustees, appointed by the general assembly or governor and this board elects the president of the university. We do not expect this president of the university to be changed because a new governor has been elected or because the other political party has come into power. Why cannot the same procedure be expected in the appointment of a State Highway Engineer? I not only think we should expect it, but we will have it. The people of a state would not stand for the change of the president of the university because of a political change in government, and the people are not going to stand much longer such changes in state highway engineers and similar officials. The people will dictate when aroused and they are now dictating that political changes in government *shall not* cause changes in our highway forces.

To our State Highway Engineer should be intrusted the

selection of *all* others who are to carry on the road work of the state, and their appointment will be subject to the approval of the Commission. This, again, is in accord with the selection of professors, instructors and assistants by the president of the state university.

Again the State Highway Engineer must have the authority to discharge any and all employees connected with the road work. Many a State Highway Engineer today is handicapped in his work by having in his department men who are inefficient, but for *political reasons* must not be removed from office. This is wrong; is not fair to the engineer, and it is decidedly not in the interest of the people of the state.

In the selection of his assistants, the State Engineer must of necessity obtain such men as are qualified to do satisfactorily, the work required of them, and, being in a position to assure them that their length of service and remuneration will be dependent upon their ability and development, will enable him to secure a higher class of men for the work. An assistant engineer, who continues in the service of the state highway engineer, should become of more and more value to him and to the work of the state, and, if he does not develop in this way, his services either will not be needed or he will be retained with no advance in salary.

Permanency of employment of road officials is, unquestionably, in the interest of economic road building; while a constant change by a state of its highway engineer is to be deplored because it will usually mean a constant change, instead of a continuing and expanding policy; yet it is almost as disastrous to a state's road work for the road forces to be constantly changing.

Compare Massachusetts with a continuing policy, with New York, with a changing policy, and the resultant road work is all in favor of Massachusetts.

The merit system is not only applicable to the engineers, but also to superintendent, foreman and in fact to every man on the job.

A superintendent's value is dependent upon how successfully he can follow the instructions of the engineer and handle his construction and maintenance forces, and this latter will depend largely on how wisely the superintendent has selected his foreman, who is in actual charge of the laborers. It is practical for the engineer to keep in close touch with all construction work so that by means of system of "cost accounting" he will *know accurately* the value of each foreman and if a certain foreman is not obtaining similar results in the same kind of work and with similar equipment as the other foreman, then he is not the man for the place. I could cite instances where counties have saved thousands of dollars from the fact that the engineer was able to know what his superintendent and forman were worth to him; and, on the other hand, we have instances where counties have, undoubtedly, lost as much as fifteen thousand dollars and more of the value of a two hundred thousand dollar bond issue, by not keeping an accurate cost account.

These men, realizing that their employment is dependent upon themselves and that, if they make good, their employment is practically continuous, will give better and better results the longer they continue in the service of the engineer and consequently are of more value to him. Are they not, therefore, worth more money to him? And is he not warranted in paying them higher salaries?

In my own state, North Carolina, we are inaugurating a system by which our better superintendents and foremen are kept constantly at work by transferring them from county to county and we are now in a position where we can command the services of the best of these men.

CHAPEL HILL, N. C.

OUR MOUNTAIN SHRUBS[1]

BY W. C. COKER

In speaking of shrubs, I feel that I have been asked to introduce your best friends, and if much that I have to say is already very familiar to you, I hope you will forgive me. I have to take for granted sometimes a lack of knowledge that does not exist, especially in an audience of this kind where there are so many who take an intelligent interest in natural history.

I do not feel a stranger in Montreat, as I have visited you several times before. About two years ago I came here and had the great pleasure of studying the wonderful vegetation of this neighborhood. I have just collected in these woods and brought in here to show you a few shrubs that are commonest in Montreat, and I am going to talk for a while about Montreat shrubs, and about North Carolina shrubs in general.

Perhaps you do not realize how slowly shrubs have come to be appreciated, even by intelligent people. When I was a boy, the ordinary garden or yard had no shrubs at all except a few specimen individuals of syringias, and probably a crepe myrtle and euonymus or two near the steps. Instead of having shrubs, they had flowers like zinias, phlox, petunias, etc., and frequently these were planted in beds laid out right in front of the house, or scattered indiscriminately in the grass.

I might say that the most significant change in the ideas of landscape effect and decorative use of plants in the past twenty-five years has been due to the final appreciation of the fact that shrubs, when properly chosen and placed, are perhaps the most important element in the decorative treatment of a home of average size. In such a place a few trees are all that can be used, but many shrubs of considerable variety may be placed to fine effect. In parks and other large

[1] An address delivered befor the N. C. Forestry Association, Montreat, N. C., July, 1915.

expanses the trees must still hold first place, but even there the shrubs are a close second, and in a yard of half an acre, for instance, the shrub is the most important element that can be used in decorative planting.

Now, this was not a recognized fact in American homes until comparatively recent times. Such landscape architects as Olmstead and Nolen, for example, have done a great deal in this country to make the people realize that shrubs, and principally our own native ones, can be used with fine effect in large masses. And if you will allow me to make any suggestions for change here in Montreat, I would say that you have not enough shrubs in the grounds. That is the only thing that I can think of for improvement in Montreat. It would pay everybody to put more of them around their homes, and especially in the large plots around the hotels. It would make a wonderful change in the appearance of the place if many more shrubs were planted.

The Europeans were the first to appreciate the American shrubs. These magnificent rhododendrons that surround you here as a wonderful free gift of nature are shown in great variety and beauty at Kew Gardens, London. If you will go there you will find a collection of these plants of all colors and kinds bordering the sides of a beautiful shaded glen. At blooming time this glen is one of the most marvelous sights in the world, and thousands of people go there to see it. Until rather recent years one had to go to Europe to see many of our handsome American shrubs and trees at their best in cultivation, and even now this is still true in many cases. But things are now beginning to change and we are using our native plants more and more. Professor Sargent, director of the Arnold Arboretum near Boston, has, for example, a garden of American rhododendrons which is perhaps equal to the display at Kew Gardens.

In the early days the Europeans sent their explorers over here to get American plants. These men penetrated the primeval wilderness of these mountains and passed not far from this very spot. Such men as André and Francois Mi-

chaux, Mark Catesby and John Fraser traveled extensively in the United States and sent to England and France seeds and living plants of a great many of our trees and shrubs. Michaux had a propagation garden at Ten Mile Station, near Charleston. He would assemble his plants there and at intervals would pack them carefully and send them to France. The two Michaux, father and son, did more than any others to open up the immense wealth of American trees and shrubs. They sent many beautiful things to Europe, where they were highly appreciated and became established immediately as among the most cherished treasures of their gardens and parks. It was one of the most exciting times in the botanical history of Europe when these pioneers were discovering the things that so many of us pass by without a glance, and sending them home as rare and wonderful things.

The flora of North Carolina is extremely rich. We have a vague notion that we are rich in North Carolina, but as to details of any kind we generally fail to specify when questions are asked. I am now going to give you a few facts, or as nearly facts as I can make them, in regard to the tree and shrub flora of North Carolina.

We have in North Carolina 182 species of trees native to the state; that is, 182 kinds which were found here by the first discoverers of North Carolina, the Indians. In addition to these there are 10 others which are established but exotic to North Carolina (this does not include apple and peach, which are occasionally spontaneous near residences).[2] This gives us a total of 192 trees for the state.

Now I shall have to explain this just a little. You all know the hawthorns, or red haws, one of which is the principal hedge plant of England, the thorn or quick so often mentioned in English literature. Now the species of hawthorn are in a remarkably unstable state, so much variation occurring in all directions that it is impossible to distinguish clearly many of the species or to tell certainly how many

[2] These introduced species are: Ailanthus glandulosa, Albizzia julibrissin, Gleditschia triacantha, Morus alba, Paulownia tomentosa, Prunus avium, Prunus cerasus, Prunus angustifolia (P. chicasa), Salix alba, Salix babylonica.

there are. There are not any two botanists in the whole country who will agree on how many hawthorn species there are in North Carolina. Mr. Beadle, of Biltmore, in his treatment of the genus in Small's Flora, credits 36 species to this state, but if the whole state were carefully explored it is almost certain that a good many other species of equal value to certain of these could be added to this number. In fact Ayres and Ashe in their list of Appalachian shrubs and trees give 16 arborescent and 30 shrubby species of Crataegus, making 46 species for these mountains alone. This will give you some idea of how botanists disagree as to where to draw the species lines in this genus.

In saying that we have 192 species of trees, I am simply taking one man's idea of the number of hawthorns of tree size (above shrub size) that occur in this state. The opinion that I have followed is that of Dr. Britton, of the New York Botanical Garden, author of a valuable work on the trees of North America. According to Dr. Britton we have in this state 13 hawthorns that are about shrub size. That is probably not the number that would be given by any other botanist, but I take this number in making up my total.

In regard to the shrubs, we have 227 native and naturalized species, not counting the hawthorns, but this is counting 24 species that are also included under trees. I will suppose arbitrarily that we have 20 species of hawthorns of shrub size. These with the 13 that we have called trees make less than Mr. Beadle's number, and less than Ayres and Ashe's number for the mountains alone, but I will err on the safe side. This will give us 247 shrubs. To this number add 192 trees and we have 439. Deduct 24 species counted twice and we have 415 trees and shrubs not counting the vines. As there are 42 vines in North Carolina this will bring the total number of woody plants to 457. It is a remarkable fact that, so far as I know, there is only one of our shrubs growing wild in North Carolina that is not native, whereas there are ten trees that are not native. We have more shrubs than trees and yet there is only one that is naturalized from beyond

our borders. It is the Scotch broom of which you have so often heard. Prof. J. S. Holmes, our state forester, has found that this interesting plant is now perfectly well established on some rocky hills in central North Carolina.

Four hundred and fifty-seven is a very large number of woody plants for one state to possess, but even so we cannot claim to stand first among the states in this respect. According to Small's recent manuals Florida has 366 trees and 538 shrubs including the woody vines. He has since found two more trees in that state, thus bringing the trees up to 368. But we cannot arrive at the correct number of species of woody plants in Florida by adding these figures together, for many species are included in both the tree and shrub books. I have not taken time to sift out the true number.

Referring to figures now at hand we find that Minnesota is credited with 274 species of trees, shrubs and vines (Clements, et al., *Minnesota Trees and Shrubs,* p. 12), and Alabama with 343 species and varieties (Mohr, *Plant Life of Alabama,* p. 44). It is surprising to find that California has only 94 species of trees (Jepson, *Trees of California,* p. 13). In Chapel Hill we have 13 species of oaks, while the whole State of California has but 14 species.

We are situated in a remarkbly favorable way for a variety of vegetation. Down in the southeast corner of North Carolina on Smith's Island is found the tall palmetto, exactly the kind that grows in Florida. At the other extreme, on the tips of Grandfather, Craggy, Roan and other of our mountains there are plants that are not known elsewhere south of New York. We have kinds native to Labrador and kinds native to the tropics. indigenous

More than three-fifths of the shrubs that are native to North Carolina are ~~endemic~~ to these mountains around you, and the great majority can be found within easy walk of Montreat. Of the 247 for all the state 154 (including 10 hawthorns) are native to the mountains.

I wish there were time to go into some detail as to the peculiarities of shrubs, their habits, and requirements, but a

few words must suffice. While passing through the dryer and hotter coastal plane, you will notice that nearly all the shrubs are confined to the swamps, bogs and low grounds. In the dry sandhills grow scarcely any shrubs, the few perennial plants that grow there, except trees, are particularly protected against desiccation by fleshy leaves and stems or large underground stems or roots where water can be stored. Such are red root or Jersey tea, a shrub with large roots, the cactus with fleshy jointed stems, yucca with thick fleshy leaves, queen's delight with fleshy stems and leaves. Though these have only a shallow rooting system, they can store up water in wet seasons and use it when dry. The great majority of shrubs are not strongly protected against desiccation and with their shallow rooting systems must suffer or even perish in dry weather unless growing in swampy situations or, as here in the mountains, in a less trying climate.

A saturated soil contains very little air and is not suitable for plants with deep root systems. Only trees with highly specialized roots, such as black gum and cypress and juniper can overcome the disadvantages of such conditions. Their roots are furnished with large air chambers, which enable the air to pass down from above. These air spaces make the roots so light that when we were boys we used them for corks. Trees without deep roots will be blown down, but shrubs are not much exposed and are therefore better fitted to live in swamps where the surface roots are a great advantage.

As I was walking about here yesterday, I was reminded of an English woman who visited our states about 85 years ago. She was Mrs. Trollope, the mother of Anthony Trollope, the famous English novelist. I do not know why she came, and from her book on "Domestic Manners of the Americans" I think she was sorry that she did. Even after so long a time it will pay us to read this book, although we have outgrown many of the worst vulgarities of those days. The only passage in the book that expresses unmodified enthusiasm and enjoyment was that in which she refers to her trip through the mountains. She passed through Virginia at the

time the rhododendrons and azaleas were in bloom, and she did not allow her disappointment in America to shadow her joy in the panorama of beauty that revealed itself from the car window.

As an illustration of American manners, Mrs. Trollope tells of the superior delicacy of a man at whose house she was spending a few weeks. Whenever she would try to give him some true conception of the English people he would not contradict, but would put his feet on the mantelpiece and whistle the *Star Spangled Banner*. This he took to be the most refined way of showing his disgust for all things English. It must be remembered that this was not very long after the war of 1812.

Many of the shrubs that you have right here in Montreat are among the most prized in the gardens of two continents. Rhododendrons, kalmias, azaleas, syringas (as we call them, in reality *Philadelphus*—the botanical name of the lilac is *Syringa*), spireas, sweet shrub, viburnums—all of these are very attractive and have been used in gardens for many years. The sweet shrub all of you know. Red haws are also commonly planted for decorative purposes. This beautiful, purplish-red flower that I have here is the flowering raspberry. I have not at hand a specimen of the elderberry, but it is a really fine shrub when properly used. Several years ago I visited the greatest nursery in the world, near London, England. The superintendent took me all over it, and at one point drew me aside to show me a particular treasure. "This is the plant we are most proud of this summer," he said as he pointed out a large American elderberry plant covered with its delicate white flowers. A shrub is not without honor save in its own country.

The dwarf locust with its conspicuous pink flowers is very pretty. We have some of them in the arboretum at the University.

The grapes being vines are not technically shrubs, but we must not pass them by for that reason. I have here two species. Now these two species are the parents of the great

majority of bunch grapes that grow in our gardens. This one, the Northern fox grape (*Vitis labrusca*), is the parent of the most famous—the Concord. The Concord grape appeared in this way. In Concord, Mass., where were the homes of Emerson and Hawthorn, and Thoreau, and Alcott, there also lived Ephram Bull on the main street. In the year 1840 some children one day gathered bunches of the wild northern fox grapes near his house and brought them up in the yard to eat. The pulps were thrown about the yard. The next year about a dozen plants came up from the seeds. Mr. Bull became interested and thought he would see how some of these plants would come out. He trailed one up on the fence and let it alone. In a few years it produced fruit that was far superior to the wild parent, and was moreover full of vigor and very prolific. Mr. Bull named it the *Concord* and all the millions of vines of that variety now have descended by slips and cuttings from that one.

The Catawba grape, another of our best and most popular bunch grapes, is also a seedling of the wild fox grape. It is of particular interest to us for it originated in the woods in Buncombe County, in a community called Murraysville, about ten miles southeast of Asheville. The grape remained in obscurity until it was distributed by John Adlum of the District of Columbia, a pioneer benefactor of American horticulture. Other fine grapes that have come from this northern fox grape, directly or indirectly, are Delaware, Niagara, Worden, Moore's Early, Eaton, etc.

This other grape that I have in my hand is the Southern summer grape (*Vitis labrusca*). From it have come the Norton's Virginia, Le Noir, Herbemont, and a good many others.

You do not have the muscadine or bullis grape wild here in Montreat, but with us in the low country it is highly respected as the parent of our delightful scuppernong and also of the James grape, Thomas, Flowers, etc.

Here is another interesting shrub that is now used much in landscape gardening. If you get any Boston landscape

man to lay our your grounds, he is almost sure to use some of these as marginal planting for the rhododendron and azalea borders, to fill in beneath them and touch the ground. Its name is yellow root, so called on account of the very bright yellow root. The stem also is yellow. This yellow pigment makes a persistent dye that was much used by the Indians, and is, I think, still used by the mountain people of this section. The plant has a little greenish blossom with a slight tint of purple.

The naming of plants is not entirely a bit of imagination, though some of it is. Many plants are named for their qualities, but many are named for men or states or countries, and some even for sentimental reasons, as to compliment a sweetheart.

Carolus Linnaeus, the great Swedish botanist, and founder of botanical nomenclature, named many of our plants that were sent to him by collectors in the early days. He used every possible consideration in naming plants, frequently as a compliment to his friends, anf often to perpetuate the names of the collectors or states. But often he was purely fanciful, and sometimes perpetrated jokes with his naming.

There is a genus of flowers, some of them wild here, that is closely related to the Wandering Jew. They have pretty blue flowers that are conspicuous along embankments here. In studying the flowers of one of these plants Linnaeus found that they had two kinds of stamens; some perfect that produced pollen, and others sterile that produced nothing. When he saw this it reminded him of three Dutch friends of his named Commelin. They were brothers and all botanists. Two of them were energetic men and published a good leal of botanical investigation. The other brother was intelligent but too lazy to publish anything. He would not take that much trouble. So Linnaeus named this plant after the Commelin brothers who were also of two kinds, fertile and sterile.

Here is the witch hazel which all of you know. It is from this, by distillation, that they make the witch hazel that is

used for cosmetics and other purposes. It is common here in Montreat. These peculiar cone-shaped exerescences all over the leaves that disfigure them so are galls that are caused by a kind of plant louse. Here are some of the witch hazel pods, and this fall if you will bring these in and put them on the mantel, you will have startling moments when they will pop open with a loud report and send the seed across the room many feet. In its time of flowering the witch hazel is quite remarkable. It scoffs at the seasons and blooms in the fall, sometimes as late as November or December. The flowers are plentiful and quite pretty and it is much desired for its lateness.

Here on the other hand is the shrub which is the earliest to flower in the spring. Certainly nothing can be more deserving of our affection than the courageous flowers that give us the first intimation that life is coming in the spring. It has a marvelously happy effect on one's disposition to see these beautiful, long yellow catkins of the alder shedding their abundant pollen in the chilly days of the early spring.

The buffalo nut or oil nut that you see here is a remarkable shrub that grows parasitically on the roots of other plants. It has a large nut with acrid juice.

Here is the horse sugar (*Symplocos tinctoria*) which has small clusters of greenish-yellow flowers in spring. The leaf, if you taste it, is decidedly sweet, and this makes it easy to distinguish this shrub from all others. Animals eat it with much avidity.

The mountain pepper bush has white flowers with a delicious odor. It is certainly worthy of cultivation.

This wild species of hydrangea, the tree hydrangea (*Hydrangea arborescens*), is not so handsome as the *Hydrangea paniculata* from Japan which is generally cultivated, but it is well worth while when planted in cool places and is often used in gardens.

Huckleberries are, of course, common, and there are many kinds of them. Here is the high-bush huckleberry and the low bush huckleberry, and there is another one, the

blueberry, which comes later on. The squaw huckleberry has a large greenish berry which is white or pink when ripe. It is bitterish but not at all poisonous.

The heath family, to which these huckleberries belong, contains the greatest number of our shrubs of any family. Among them are rhododendron, azalea, arbutus, kalmia, sweet pepper-bush, wintergreen, fetter-bush, andromeda, stagger-bush, cranberry, and other plants less conspicuous which we would hardly recognize as of any consequence. It contains 54 of our North Carolina shrubs. Next comes the rose family with 45 species, including 20 hawthorns, the classification of which, as I have already said, is in such a badly confused state that it is impossible to say how many there really are. Even if the number of species were agreed on, their separation into trees and shrubs would be largely arbitrary. Other well known members of this family are roses, blackberries, raspberries, plums and cherries.

The Saxifrage family has ten species including syringas, hydrangeas, gooseberries, currants, etc. The holly family includes twelve species in North Carolina. That is, we have twelve bush forms of holly, leaving out the well known tree with the prickly leaves. Several hollies that I include in the shrubby forms, such as *Ilex vomitoria, I. cassine,* and *I. decidua* may also become small trees.

Other important families are the sumachs, with nine species; the honeysuckle family with sixteen species; and the St. John's-Wort family with thirteen species.

These references are only to the shrubs and do not include vines, which, with the exception of a few grapes, we have not treated at this time.

Below is appended a table showing in convenient form the number of woody plants in our state:

Native trees	182	
Naturalized trees	10	
Total trees		192

Native shrubs	246	
Naturalized shrubs	1	
Total shrubs		247
Native vines	41	
Naturalized vines	1	
Total vines		42
Total		481
Deduct, counted twice		24
Number of woody plants in North Carolina		457

The 24 species counted twice, because sometimes shrubs and sometimes trees, are as follows:

Amelanchier oblongifolia (T. & G.) Roem.
Aralia spinosa L.
Asimina triloba Duval.
Castanea pumila (L.) Miller.
Cyrilla racemiflora L.
Hamamelis virginiana L.
Ilex Beadlei Ashe.
Ilex cassine L.
Ilex decidua Walter.
Ilex montana T. & G.
Ilex myrtifolia Walter.
Ilex vomitoria Ait.
Kalmia latifolia L.
Prunus angustifolia Marsh.
Prunus virginiana L.
Rhamnus caroliniana Walt.
Rhododendron catawbiense Michx.
Rhododendron maximum L.
Salix discolor Muhl.
Rhus Vernix L.
Symplocos tinctoria (L.) L'Her.
Viburnum Lentago L.
Viburnum obovatum Walt.
Vaccinium arboreum (Marsh.) Nutt.

I add below a list of the shrubs that grow in our North Carolina mountains at an elevation of 2.000 feet and over:

SHRUBS OF THE NORTH CAROLINA MOUNTAINS

GYMNOSPERMS

Coniferae (Pine Family):

Juniperus communis L.

This is one of the rarest of North Carolina plants. The upright form has been collected on Crowder's Mountain, Gaston County (Gray Herbarium). A prostrate form of it has been collected on Mt. Satula, Macon County, by the Biltmore staff and is determined by them as *J. nana*, Willd. (= *J. communis*, var. *montana*, Ait.). We have not counted this as separate in making up our totals.

MONOCOTYLEDONS

Gramineae (Grass Family):

Arundinaria tecta (Walt.) Michx.

DICOTYLEDONS

Salicaceae (Willow Family):

Salix tristis Ait.
Salix humilis Michx.
Salix cordata Muhl.
Salix sericea Marsh.
Salix discolor Muhl.

Myricaceae (Wax Myrtle Family):

Comptonia asplenifolia Ait. Curtis gives this only in Middle and occasionally in Lower District, but it is not uncommon at elevations of 3,000 to 4,000 feet, as on Pisgah, Crowder's Mountain and along the Blue Ridge.

Cupuliferae (Birch Family):

Corylus americana Walt.
Corylus rostrata Ait.
Alnus crispa (Ait.) Pursh. (A. viridis, Gray's Manual, Ed. 6).
Alnus rugosa (Du Roi) Spreng.

Santalaceae (Sandlewood Family):
- Pyrularia pubera Michx.
- Nestronia umbellula Raf. (Darbya umbellulata Gray).
- Buckleya distichophylla (Nutt.) Torr.

Loranthaceae (Mistletoe Family):
- Phoradendron flavescens (Pursh.) Nutt.

Ranunculaceae (Crowfoot Family):
- Zanthoriza apiifolia L'Her.

Calycanthaceae (Sweet Shrub Family):
- Calycanthus floridus L.
- Calycanthus fertilis Walt. This includes, according to Gray's Manual, 7th. Ed., both C. laevigata and C. glauca Willd. as given in Curtis' list.

Berberidaceae (Barberry Family):
- Berberis canadensis Mill.

Ericaceae (Laurel Family):
- Benzoin aestivale (L.) Nees.

Saxifragaceae (Saxifrage Family):
- Philadelphus inodorus L.
- Philadephus grandiflorus Willd.
- Hydrangea arborescens L.
- Hydrangea cinerea Small.
- Hydrangea radiata Walt.
- Itea virginica L.
- Ribes cynosbati L., and var. glabratum Fernald.
- Ribes gracile Michx.
- Ribes rotundifolium Michx.
- Ribes prostratum L'Her (R. glandulosum Grauer).

Hamamelidaceae (Witch Hazel Family):
- Hamamelis virginiana L.
- Fothergilla Major Lodd.

Rosaceae (Rose Family):
- Physocarpus opulifolius (L.) Maxim.

Spirea corymbosa Raf.
Spirea virginiana Britton.
Spirea salicifolia L.
Spirea tomentosa L.
Aruncus sylvester Kost. (A. Aruncus Karst.)
Pyrus arbutifolia (L.) L. f.
Pyrus melanocarpa (Michx.) Willd.
Crataegus—numerous uncertain species (not enumerated).
Rubus idaeus L. var. aculaetissimus (C. A. May) R.&T.
Rubus occidentalis L.
Rubus odoratus L.
Rubus allegheniensis Porter (R. nigrabaccus Bailey).
Rubus canadensis L.
Rubus hispidus L.
Rubus villosus Ait.
Rosa carolina L.
Rosa humilis Marsh.
Prunus virginiana L.
Prunus cuneata Raf. This seems to have been found so far only in Henderson County (Biltmore Herb, N. Y. Bot. Garden, W. W. Ashe).
Prunus umbellata Ell. Recently added to North Carolina by Memminger's list of Henderson County plants in MITCHELL JOURNAL 30: 136, 1915.

Leguminosae (Pulse Family):
Amorpha fruticosa L.
Amorpha virgata Small. In Ayres and Ashe's list.
Amorpha montana Boynton.
Robinia hispida L.
Robinia Boyntonii Ashe.

Rutaceae (Rue Family):
Ptelea trifoliata L.

Anacardiaceae (Cashew Family):
Rhus radicans L.

Rhus Toxicodendron L. (R. quercifolia (Michx.) Steud. This is given in Ayres and Ashe's list of Appalachian shrubs, but Curtis gives it only "From the coast to the lower part of the Upper District," and Small says: "In pine woods and the foot hills."

Rhus vernix L.

Rhus typhina L.

Rhus glabra L.

Rhus copalina L.

Rhus canadensis Marsh. (R. aromatica Ait.).

Aquifoliaceae (Holly Family):

Ilex verticillata (L.) Gray.

Ilex laevigata (Pursh.) Gray.

Ilex longipes Chapm. In Ayres and Ashe's list.

Ilex decidua Walt.

Ilex monticola A. Gray.

Ilex Beadlei Ashe.

Celastraceae (Staff Tree Family):

Euonymus atropurpureus Jacq. This is one of the rarest plants in North Carolina and is known in collections only from Chapel Hill. It is given in Ayres and Ashe's list of Appalachian shrubs, but probably without exact data, as Mr. Ashe informs me that he has not seen it. Mr. F. E. Boynton, of Biltmore, writes me that he once saw it near Hewits Station, Swain County.

Euonymus americanus L.

Euonymus obovatatus Nutt. This is given in Memminger's list of Henderson County plants. Gray's Manual gives it only from W. Ontario to Pa., Ky., Ill. Small's Flora from Ontario to Penn., Ill. and Tenn. The Biltmore Nursery staff have grown what they took to be this species from Craggy Mountains.

Pachistima Canbyi. A. Gray. Small gives this from North Carolina and Virginia; Gray's Manual from Virginia and West Virginia.

Staphyleaceae (Bladder Nut Family):
Staphylea trifolia L.

Rhamnaceae (Buckthorn Family):
Rhamnus lanceolata Pursh. Collected in 1843 near Hendersonville by Asa Gray. Not in Curtis' or Ayres and Ashe's list.
Ceanothus americanus L.

Ternstroemiaceae (Camellia Family):
Stewartia pentagyna L'Her. "From Wake to Cherokee": Curtis. This has been collected at Mt. Airy, Highlands, Macon County, Cherokee County, etc.

Hypericaceae (St. John's-Wort Family):
Asyrum hypericoides L.
Hypericum graveolens Buckley.
Hypericum prolificum L.
Hypericum densiflorum Pursh.
Hypericum Buckleyi M. A. Curtis.
Hypericum nudiflorum Michx.
Hypericum glomeratum Small.[4]

Cistaceae (Rockrose Family):
Hudsonia montana Nutt. "Dry summit of Table Rock and adjacent peaks": Small.

Araliaceae (Ginseng Family):
Aralia spinosa L.

Thymelaeaceae (Mezereum Family):
Dirca palustris L.

Ericaceae (Heath Family):
Clethra acuminata Michx.
Azalea arborescens Pursh.
Azalea viscosa L. and var. nitida (Pursh.) Britton.
Azalea lutea L.
Azalea canescens Michx.

[4] Summits of Grandfather Mountain, Table Rock, Etc. A number of species of Hypericum that are perennial at base only are not considered shrubby and are omitted.

Azalea nudiflora L.
Rhododendron Vaseyi Gray.
Rhododendron maximum L.
Rhododendron catawbiense Michx.
Rhododendron carolinianum Rehder.
Rhododendron minus Michx.[5]
Menziesia pilosa (Michx.) Pers.
Kalmia angustifolia L.
Kalmia carolina Small.
Kalmia latifolia L.
Leucothoe Catesbaei (Walt.) Gray.
Leucothoe recurva (Buckley) Gray.
Leucothoe recemosa (L.) Gray. In Ayres and Ashe's list.
Dendrium prostratum (Loud.) Small.
Dendrium Hugeri Small.
Chamaedaphne calyculata (L.) Moench.
Pieris floribunda (Pursh.) B. & H.
Xolisma ligustrina (L.) Britton. Ayres and Ashe's list.

[5] In Rhodora 14:97, 1912, Alfred Rehder sets forth the interesting fact, discovered at the Arnold Arboretum, that what we have been calling *Rhododendron punctatum* is in reality composed of two distinct species, the real *R. punctatum* Andr., lower altitudes in N. C., S. C. (?), Tenn., Ga. and Ala., and an unnamed form seemingly confined to the higher altitudes in North Carolina. To this last Rehder gives the name *R. carolinianum*, and he supplants the name *punctatum* of Andrews for *minus* of Michaux which antedated it for the low-altitude form. After giving a detailed description of his new species Rehder says: "*Rhododendron carolinianum* is easily distinguished from *R. minus* by the short and wide tube of the corolla as long as, or slightly shorter than the lobes; the corolla is usually not spotted and is glabrous outside, the leaves are generally broader, less pointed and of thicker texture, the branches are shorter and stouter forming a compact, usually low shrub and the flowers appear several weeks earlier, before the young leaves are out. As an ornamental plant it is superior to *R. minus* and has proved perfectly hardy at the Arnold Arboretum and at General Weld's garden at Dedham where a large number of plants have been established for several years."

He also says that *R. carolinianum* "forms a low compact bush with broad leaves, flowering after the middle of May before the development of the shoots of the year, while the other plant (*R. minus*) which agrees exactly with the form figured by Andrews and cultivated formerly in European gardens, is a taller loose-growing shrub with narrower leaves, and it flowers about four weeks later, when the young shoots springing from below the inflorescence are already developed and overtop it. Generally the differences as regards habit, shape of the leaves, time of flowering and also the shape of the corolla are about the same as those between *R. catawbiense* and *R. maximum*, only in a lesser degree. In examining the available herbarium material I find that both forms are native to the Southern Atlantic States; the low compact form being apparently restricted to the high mountains of North Carolina, while the other form inhabits lower altitudes and has a wider distribution."

Epigaea repens L.
h Gaulteria procumbens L.
Gaylussacia dumosa (Andr.) T. & G.
Gaylussacia frondosa (L.) T. & G.
Gaylussacia ursina (M. A. Curtis) T. & G.
Gaylussacia baccata (Wang.) C. Koch (G. resinosa (Ait.) T. & G.)
Vaccinium arboreum (Marsh) Nutt.
Vaccinium stamineum L.
Vaccinium malanocarpum Mohr.
Vaccinium corymbosum L. We may also have the var. *amoenum* (Ait.) Gray. In Ayres and Ashe's list *V. virgatum* occurs in error for *V. corymbosum.*
Vaccinium atrococcum (Gray) Heller.
Vaccinium pallidum Ait.
Vaccinium vacillans Kalm.
Vaccinium hirsutum Buckley.
Vaccinium erythrocarpon Michx.
Vaccinium Oxycoccus L.[6]

Styracaceae (Storax Family):
Symplocos tinctoria (L.) L'Her.[7]

Caprifoliaceae (Honeysuckle Family):
Diervilla Lonicera Mill. (D. Diervilla Mac.M.).
Diervilla sessilifolia Buckl.
Diervilla rivularis Gattinger.
Symphoricarpos recemosus Michx.
Symphoricarpos orbiculatis Moench. (S. symphoricarpos MacM.).
Virburnum alnifolium L.
Virburnum acerifolium L.

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[6] Small has *V. simulatum Small* (N. Y. to Ala.), which Gray does not admit, and Small has not the *V. corymbosum* var. *amoenum* mentioned above, that Gray gives.
[7] Ayres and Ashe give *Styrax americana* in their list of Appalachian shrubs, but this is an error. It is confined to the coastal plain. *Styrax grandifolia* occurs as far west as Lincoln County (Curtis).

Virburnum molle Michx. This is not allowed for North Carolina by Gray's Manual, but is included in our flora by Ayres and Ashe and by Small.
Virburnum pubescens (Ait.) Pursh.
Virburnum cassinoides L.
Virburnum nudum L.
Virburnum Lentago L.
Sambucus canadensis L.
Sambucus pubens Michx.

The number of shrubs in the above list is 144. If we add somewhat arbitrarily ten species of Crataegus to this list it will give us a total of 154 mountain shrubs for North Carolina. We also add below a list of the mountain vines:

VINES OF THE NORTH CAROLINA MOUNTAINS

MONOCOTYLEDONS

Liliaceae (Lily Family):
Smilax rotundifolia L.
Smilax glauca Walt.
Smilax hispida Muhl.
Smilax bona-nox L.

DICOTYLEDONS

Aristolochiaceae (Birthwort Family):
Aristolochia macrophylla Lam. (A. Sipho L'Her.).

Ranunculaceae (Crowfoot Family):
Clematis virginiana L.
Clematis viorna L.
Clematis verticillaris D. C. (Atragene americana Sims). This is given from the North Carolina mountains by Curtis on authority of others. Gray allows it only to Va., but Small extends it to N. C.

Menispermaceae

Menispermum canadense L.[8]

Anacardiaceae (Cashew Family):

Rhus radicans L. There is also a form with smaller fruit, var. *microcarpa* Michx., occurring locally from Canada to Fla. that should be looked for in this state.

Celastraceae (Staff Tree Family):

Celastrus scandens L. In Ayres and Ashe's list, but apparently rather rare in N. C. It has been collected in moist woodlands near Biltmore in 1898 (Biltmore Herb.), on Cane Creek, Mitchell County, and at Spruce Pine (W. W. Ashe), and at Scheville (N. Y. Bot. Garden). Curtis knew of but one vine, which was near Lincolnton.

Vitaceae (Vine Family):

Psedera quinquefolia (L.) Green (Parthenocissus quinquefolia (L.) Planch.).

Vitis labrusca L.

Vitis aestivalis Michx.

Vitis bicolor Le Conte.

Vitis cordifolia Michx.

Vitis Baileyana Munson.

Vitis vulpina L.

Vitis rotundifolia Michx.[9] In Ayres and Ashe's list. ~~but probably does not occur at an elevation of 2,000 feet.~~ It has been collected at Chimney Rock by the Biltmore staff, ~~and~~ Mr. F. E. Boynton informs me that he has seen it at Mine Hole Gap Buncombe County at an elevation of over 2000 feet.

Caprifoliaceae (Honeysuckle Family):

Lonicera sempervirens L.

Lonicera dioica L. (L. parviflora Lam.) Curtis says "This belongs to the mountains." It does not occur in Ayres and Ashe's list.

[8] Ayres and Ashe have included *Wistaria frutescens* (Pulse Family) in their list of Appalachian shrubs and vines, but this almost certainly is an error. Mr. Ashe has recently informed me that he has not seen it out of the coastal plain.

[9] *Tecoma radicans* (L.) Juss., (Trumpet vine, Bignonia Family), reaches the foot of the mountains according to Curtis, but it does not seem to ascend to 2,000 feet. It does not occur in my notes on Black Mountain or Hendersonville (Kanuga) plants, and is not in Memminger's list of Henderson County plants, or in Ayres and Ashe's list.

Lonicera flava Sims (in Curtis' list as L. grata Ait.).

Lonicera glaucescens Rydb. In Ayres and Ashe's list. Gray allows this only south to Va.

These 23 vines when added to the shrubs give us a total of 177 shrubs and woody vines for the mountains of North Carolina.

CHAPEL HILL, N. C.

OBSERVATIONS ON THE LAWNS OF CHAPEL HILL

BY W. C. COKER AND E. O. RANDOLPH

In connection with the study of the grass and lawn problem in the South that has been undertaken by the Botanical Department of the University of North Carolina, we have thought it helpful to make some accurate observations on the actual preparation, situation and constitution of a number of Chapel Hill lawns. Most of the observations were made in the spring of 1914, some in the spring of 1915. They were made too early in the growing season to take account of the strictly summer grasses and weeds, such as crab grass, foxtail grass, crowfoot grass, Japan clover, etc., which are abundant in many of our lawns. Bermuda, though still brown could usually be detected and noted. The observations follow:

1. This lawn was sown in the fall of 1912 with Woods lawn mixture. It is a good garden loam, has little shade, and is moderately watered. Results:

Red top	40%
Rye grass	40%
Sheep fescue	8%
Blue grass in shade (little elsewhere)	90%

Weeds: Plantain, chickweed, mouse-ear chickweed.

2. This lawn has not been sown for many years. The soil is of good texture, but now rather poor; not fertilized, and not watered or regularly mowed. Results:

Blue grass in shade	90%
Sweet vernal grass in partial shade	90% or less

Weeds: Hop clover (*Trifolium procumbens*), and black medic (*Medicago lupulina*) form most of the sod in open places. They come up in January or February, flower in April and May, and die in May and June.

3. This lawn was sown with Woods lawn mixture in the fall of 1912. The soil is a rather poor gravelly loam.

Stable manure was used at the time of sowing, and bone meal has been twice used as a top dressing. The lawn is about half shaded, watered only near the house and regularly mowed. Results:

Sheep fescue so thick over most of the area as to make a very good effect. Blue grass only in richer places.

Weeds: white clover in abundance; plantain and dock scattered.

4. The lawn was sown with Woods lawn mixture in the fall of 1910. Soil is loam, partial shade. Stable manure was used for fertilizer, the ground well ploughed, peas sown, and this followed with the grass mixture; regularly watered and mowed; cotton seed meal used as a top dressing. Places exposed to sun have been sown several times. Results:

Blue grass in shade	30%
Red top	30%
Sheep fescue	20%

Weeds: Very few, much moss.

5. This lawn was sown with Woods evergreen mixture in the spring of 1911, and resown in the spring of 1913. Part of the lawn was recently a garden spot; the other part is a made soil from excavation. No fertilizer used at first, but a top dressing of stable manure in 1913. There is very little shade; no regular watering, but mowed regularly. Results:

Bare ground	20%
Blue grass in shade	10%
Red top	10%
Rye grass	5%
Bermuda grass	15%

Weeds: Chickweed bad and solid on large areas, wild onions, dock, etc.

6. The lawn here is natural. Soil is gravel and clay; some shade; no water; no fertilizer. Results:

Blue grass	40%
Bermuda grass	15%

Weeds: White clover about 20%, plantain about 20%, chickweed bad in spots, some dock, *Ranunculus parviflorus* plentiful.

7. This has been a natural lawn for at least fifty years. The soil is a gravel, and is rolling; no fertilizer except ashes; heavily shaded; regular mowings; occasional waterings. Results:

Blue grass	75%
Bermuda grass	5%
Sheep fescue	3%

Weeds: White clover, hop clover, plantain in small amount, smut grass plentiful in spots.

8. The lawn was sown in 1904 with Wood's evergreen mixture. The soil is a loam and is rolling. No preparation was made previous to sowing except lawn cleared from stumps, rocks, etc. The seeds were raked in with a small hand rake. No fertilizer was used. There is but little shade. It receives careful attention in being regularly mowed and watered. Results:

Blue grass	80%
Red top	5%
Creeping bent	5%
Rye grass	5%

Weeds: White clover, hop clover, plantain, Paspalum sp. Very little clover in spring of 1915.

9. Wood's lawn mixture was used on this lawn in 1909, following a preparation of good plowing, stable manure and peas. The soil is a gravelly loam. There is partial shade. The lawn is frequently mowed and occasionally watered. Results uneven:

Blue grass	20%
In north side about	90%
Sheep fescue	a little
Bare ground	10%

Weeds: Plantain abundant, smut grass and plantain forming most of growth in south side, some hop clover, daisies, and dandelion.

10. This lawn was sown with Wood's lawn mixture in fall of 1904. The fertilizer used was stable manure. Part of the lawn has been resown. The soil is loam. Some shade; regularly watered and mowed. Results:

Blue grass	80%
Bermuda grass	10%
Red top	5%
Low spear grass (*Poa annua*)	plentiful in spots

Weeds: Hop clover, plantain, dandelions, onions, chickweed, a good deal of moss.

11. Following a crop of peas, Wood's lawn mixture was sown in 1909. Stable manure was used as fertilizer. The lawn is partly shaded, regularly mowed, but not regularly watered. Results:

Blue grass	30%
Bermuda grass	5%
Red top	5%

Weeds: Hop clover about 30%, white clover, onions, chickweed, dandelions. In spring of 1915 chickweed had covered ground in large part, killing out grasses; *Ranunculus parviflorus* is also plentiful now.

12. The lawn was sown with Wood's lawn mixture in 1904, following peas, with stable manure as a top dressing. There is but little shade, but the lawn is regularly watered and mowed. Results:

Blue grass	75%
Red top	5%
Bermuda grass	5%
Creeping bent	5%

Weeds: Chickweed, dandelions, onions, and plantain.

13. This has been a natural lawn for at least forty years. No fertilizing or watering, but regularly mowed; heavily shaded. Results:

Blue grass	80%
Bare ground	15%

Weeds: Smut grass plentiful in spots, curled grass (as in old Mangum lawn), American pennyroyal (*Hedeoma pulegioides*). (Danthonia sp

14. A natural lawn for at least 15 years. It is well shaded, especially with cedars; not watered; occasionally mowed. Results:

Blue grass is about 95% in greater part of the lawn. There is some sweet vernal grass, and Paspalum.

Weeds few, mostly plantain; some *Ranunculus parviflorus, Oxalis stricta* and hop clover. In low places there is much grape hyacinth (*Muscari botryoides*). Under one of the cedars there is a large mat of Gill-over-the-ground (*Glecoma hederacea*).

In dry weather the grass under the cedars becomes parched sooner than elsewhere on the lawn.

15. This is a natural lawn, not having been sown nor fertilized. The soil is loam, being low, damp, very mossy, and well shaded. Results:

Blue grass is dominant, but scattered and becoming replaced by clovers and moss. Red fescue and sheep fescue are found scattered.

Weeds: White clover, hop clover, and black medic are abundant and furnish much of the green for the lawn. Other weeds are plantain, a few onions, some daisies, daisy fleabane (*Erigeron ramosus*), *Ranunculus parviflorus,* and grape hyacinth.

16. The lawn is made up of fair soil; some shade and watering. In part the lawn is of made soil and this part has been sown several times within the past two or three years with Wood's lawn mixture. Results:

Practically a failure, the ground being covered largely by weeds. The dominant weeds are hop clover, black medic, *Veronica Tournefortii, Ranunculus parviflorus,* Bermuda grass, and Paspalum.

In the undisturbed portion one well shaded corner of the lawn shows about 95% red fescue (*Festuca rubra*) and some blue grass, giving a rather good effect. Another shaded corner under a large tree of *Albizzia Julibrissin* shows about 95% blue grass with excellent effect.

17. This is a natural lawn, not having been sown for at least twenty-five years. Stable manure is applied nearly every spring, and bone meal has been used several times as a top dressing. The lawn is well shaded, occasionally watered in most open places, and frequently mowed. The sub-soil is rather impervious to water, and this is specially indicated by the considerable amount of moss present. Results:

Blue grass in shade and higher places..................	90%-100%
Carex texensis in low, damp, shaded places..............	90%-100%
Paspalum, in spots	30%- 40%

Weeds: Smut grass almost solid in places, but not widely scattered, some plantain, a few onions and daisies, and a very little hop clover.

18. The lawn was prepared and sown in the fall of 1913 with Wood's evergreen mixture and Woods drought resisting lawn mixture in equal parts. One part of the lawn is made soil from excavation. There is some shade and the lawn is partly watered. Results:

At present 90% of the green is rye grass. The other components are too small in size to be accurately determined.

In the spring of 1915 the results appear as follows:

Rye grass	40%
Blue grass	20%
Red top	25%
Red fescue	15%

Almost no weeds.

19. This lawn was carefully prepared and sown in the fall of 1913 with Wood's evergreen mixture. It is well shaded and regularly watered and mowed. Results:

At present (1914) the green is a dense growth of blue grass and white clover, with some rye grass and red top. The blue grass shows nicely after the first mowing. Spring of 1915 shows a good lawn almost entirely of blue grass, a little red top. Clover almost all gone.

Weeds: The only noticeable weed is a considerable quantity *Geranium molle,* which was probably sown with the grass mixture.

20. This lawn is a natural one, being very old. It occurs on a sloping, heavily shaded, poor soil. It is badly neglected, not being either mowed, fertilized, or watered. Results:

The dominant grass is *Danthonia spicata.* Blue grass persists and gives about 10% of the lawn.

Weeds: Plantain, elephant's foot (*Elephantopus carolinianus*), Japan clover (*Lespedeza striata*), and under the trees there are large areas of periwinkle (*Vinca minor*).

21. As an example of the natural growth in open, partially shaded places we have examined the grassed area between the sidewalk and street along Franklin Street, near the President's house, which is representative of the other streets in town. This strip has never been sowed and receives no attention except occasional mowings with the blade.

The following plants (arranged in the order of abundance) were the most plentiful:

Blue grass (*Poa pratensis*).
Bermuda grass (*Cynodon Dactylon*).
Sweet vernal grass (*Anthoxanthum odoratum*).
Orchard grass (*Dactylis glomerata*).
Smut grass (*Sporobolus indicus*).
White clover (*Trifolium repens*).
Black medic (*Medicago lupulina*).
Low hop clover (*Trifolium procumbens*).
Red clover (*Trifolium pratense*).
Red fescue (*Festuca rubra*).
Annual fescue (*Festuca myuros*).
Rabbit-foot clover (*Trifolium arvense*).

Others of frequent occurrence were:

Narrow leaved plantain (*Plantago lanceolata*).
Wild onion or wild garlic (*Allium vineale*).
Dandelions (*Teraxicum erythrospermum* and *T. officinale,* the former the most plentiful).
American pennyroyal (*Hedeoma pulegioides*).
Daisy (*Chrysanthemum Leucanthemum*).
Johnson grass (*Sorghum halepense*).

CHAPEL HILL, N. C.

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VOLUME XXXI DECEMBER, 1915 No. 3

THE VASCULAR RESPONSE OF THE KIDNEY IN IN ACUTE URANIUM NEPHRITIS—THE INFLUENCE OF THE VASCULAR RESPONSE ON DIURESIS[1]

WM. DEB. MACNIDER

From the Laboratory of Pharmacology of the University of N. C.
Received for publication, May 30, 1914

INTRODUCTION AND REVIEW OF PREVIOUS EXPERIMENTS

The following investigation, which has primarily as its object a study of the vascular response of the kidney in acute uranium nephritis, serves as the concluding number of two other papers which have appeared in this journal (1 and 2).

The previous articles have been concerned with the effect of different diuretics in acute uranium nephritis and with the part played by the anesthetic employed in the experiments in determining the efficiency of the nephritic kidney.

In the experiments which have been referred to, there was constantly associated with the development of an anuria, or with a condition approaching anuria, histological evidence

[1] Reprinted from *The Journal of Pharmacology and Experimental Therapeutics*, Vol. VI, No. 1, September, 1914. Presented in abstract before the Society for Pharmacology and Experimental Therapeutics, Philadelphia, December 29, 1913.

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of severe tubular injury. There was not, however, any constant or marked histological evidence of vascular injury.

The response of the renal vessels to various types of stimuli in these anuric and practically anuric animals was apparently sufficient to induce a flow of urine; yet in this group of experiments the animals remained anuric.

It seemed, therefore, advisable to determine, if possible, whether the epithelial involvement of the kidney was the primary cause for the development of the anuric state, or whether associated with the degenerative changes in the epithelium, the vascular mechanism of the kidney even though it showed no evidence of histological changes of a degenerative character, had become functionally incompetent. This incompetency, if it does exist, could be best determined not by comparing the vascular response of a nephritic animal with a normal animal, but by comparing the vascular response of animals nephritic from the same quantity of the nephrotoxic substance which following an anesthetic may either become anuric or remain diuretic.

The experiments which form the basis for this communication have been conducted on the same general plan as were the experiments of Schlayer (3) and his associates, and of the more recent experiments of Pearce, Hill and Eisenbrey (4). An early acknowledgment of my indebtedness to these investigators is therefore eminently proper.

The observation was first made by Pearce (4) that certain animals nephritic from potassium dichromate, uranium nitrate or corrosive sublimate following an anesthetic became anuric. It was also observed by Pearce that in certain animals nephritic from uranium and anuric following an anesthetic, the kidney vessels were responsive to such peripheral stimuli as adrenalin, hypertonic sodium chloride solution and caffein.

The phenomenon of vasodilation with little or no diuresis was considered by Pearce to be due to an impermeability of the glomerulus which follows the anesthetic.

As a result of the previously mentioned observations (1

and 2) which have been made concerning the relation which exists between the degree of epithelial damage and the efficiency of the nephritic kidney, the following experiments have been undertaken in the hope of ascertaining which element of the kidney, vascular or epithelial, is most concerned in the establishment of an anuria.

The following investigation is, therefore, concerned with the group of animals nephritic from uranium which following an anesthetic become anuric (Group II) and also with other animals that will serve as control experiments (Groups I and III) which are nephritic from the same quantity of uranium yet following an anesthetic do not become anuric.

A study of the vascular response of the kidney, the influence of the vascular response on diuresis, and the pathology of the kidney in these anuric and diuretic animals will furnish the material for this investigation.

DISCUSSION OF THE TECHNIQUE EMPLOYED IN THE EXPERIMENTS

In conducting the experiments two types of anesthetics have been employed: Gréhant's anesthetic and morphine-ether.

Depending upon the type of anesthetic used in the experi-

TABLE 1

Group I. Control experiments—Gréhant's anesthetic. The vascular response of the kidney in animals remaining diuretic, following Gréhant's anesthetic

NUMBER OF EXPERIMENT	URINE DAY OF EXPERIMENT	NORMAL RATE OF URINE FLOW PER MINUTE	VASCULAR RESPONSE OF KIDNEY FROM CAFFEIN	EFFECT OF CAFFEIN ON URINE FLOW	VASCULAR RESPONSE OF KIDNEY FROM ADRENALIN	EFFECT OF ADRENALIN ON URINE FLOW
1	475	7	+88	12	—68	4
2	580	2	+89	5	—30	5
3	634	5	+32	8	—72	1
4	375	6	+47	8	—62	2
5	547	3	+46	6	—76	0
6	708	0	+32	12	No record	0
		0	+81	0	—48	0

Table 2

Group II. The vascular response of the kidney in animals anuric, following Gréhant's anesthetic

Number of experiment	Urine day of experiment	Normal rate of urine flow per minute	Vascular response of kidney from caffein	Effect of caffein on urine flow	Vascular response of kidney from adrenalin	Effect of adrenalin on urine flow
1	580	0	+66	0	—42	0
2	1018	0	+17	0	—16	0
3	777	0	+40	0	—20	0
4	650	0	+63	0	—72	0
5	1531	0	+71	0	—40	0
6	115	0	+93	0	—58	0
7	685	0	+65	0	—68	0

ments and also depending upon the age of the animal, the animals used in these experiments fall into three groups.

Group I (table 1) represents those animals which following Gréhant's anesthetic have remained diuretic. Group II (table 2) represents those animals which following the same amount of Gréhant's anesthetic per kilogram have become anuric, while Group III (table 3) represents all the

Table 3

Group III. Control experiments—Morphine-ether anesthesia. The vasular response of the kidney in animals diuretic, following morphine-ether

Number of experiment	Urine day of experiment	Normal rate of urine flow per minute	Vascular response of kidney from caffein	Effect of caffein on urine flow	Vascular response of kidney from adrenalin	Effect of adrenalin on urine flow
1	747	4	+71	10	—33	6
2	697	9	+38	18	—60	6
3	645	8	+55	12	—21	4
4	582	4	+39	7	—51	2
5	455	1	+37	5	Rupt're of rubber b'g in oncometer	0
6	359	1	+87	1	—18	0

animals in the series which receive morphine-ether. All of the animals of the last group were diuretic at the beginning of the experiment. During the course of the experiments two of the animals became anuric.

All of the animals employed in the experiments were given subcutaneously 6.7 mgm. of uranium nitrate on two successive days. At the end of forty-eight hours following the initial injection of uranium the animals were anesthetized and employed for physiological study.

In these experiments the percentage of glucose in the urine and apparently the severity of the albuminuria were largely dependent upon the age of the animal. The changes in the urine from uranium and the influence of the age of the animal in determining the severity of these changes have been discussed in a previous publication (2).

During the course of the experiments the changes in general blood pressure were obtained from a canula in the carotid artery. The blood pressure changes and the changes in the heart volume were recorded simultaneously by an ordinary mercury manometer and a Hürthle manometer.

The changes in kidney volume were determined by using the following method: The left kidney was constantly employed for the observations. It is more accessible than the right kidney and, therefore, necessitates less handling during its arrangement in the oncometer. The kidney was not decapsulated. Without the fat being dissected away from around the renal vessels the kidney was placed in a copper oncometer. Within the oncometer the kidney rested on and was surrounded by a thin rubber bag filled with water. Leading from the rubber bag was a rubber tube which could either be connected with a piston recorder, that indicated the changes in kidney volume along with the blood pressure changes on the kymograph tracing, or it could be connected with a water manometer whereby the changes in kidney volume could be indicated in millimeters of water. Both of these methods were employed with each animal.

The changes in kidney volume when the piston recorder

was used were obtained in millimeters by measuring the rise or fall in the lever from the normal point that it had previously indicated on the tracing. These changes in volume will be indicated by the use of + and — signs.

During each experiment one observation was made on the effect on urine flow of an exaggerated constriction of the renal vessels, by inducing the constriction while the kidney volume was increasing from the use of caffein which had induced a dilatation of the kidney vessels. With this exception, after the use of any substance which altered the volume of the kidney, time was allowed for the lever of the piston recorder to regain its normal point. This was determined by measuring the distance between the lever and the base line.

The substances which were employed to test the response of the renal vessels were caffein for its peripheral dilator effect, and adrenalin for its peripheral constrictor effect. The caffein was employed in the dose of 1cc. per kilogram or a 1 per cent solution, while adrenalin was used in the dose of 1 minim of the 1—1000 solution. (Parke, Davis and Company). Two cc. of the adrenalin solution which was used was equivalent to 1 minim of the 1-1000 solution.

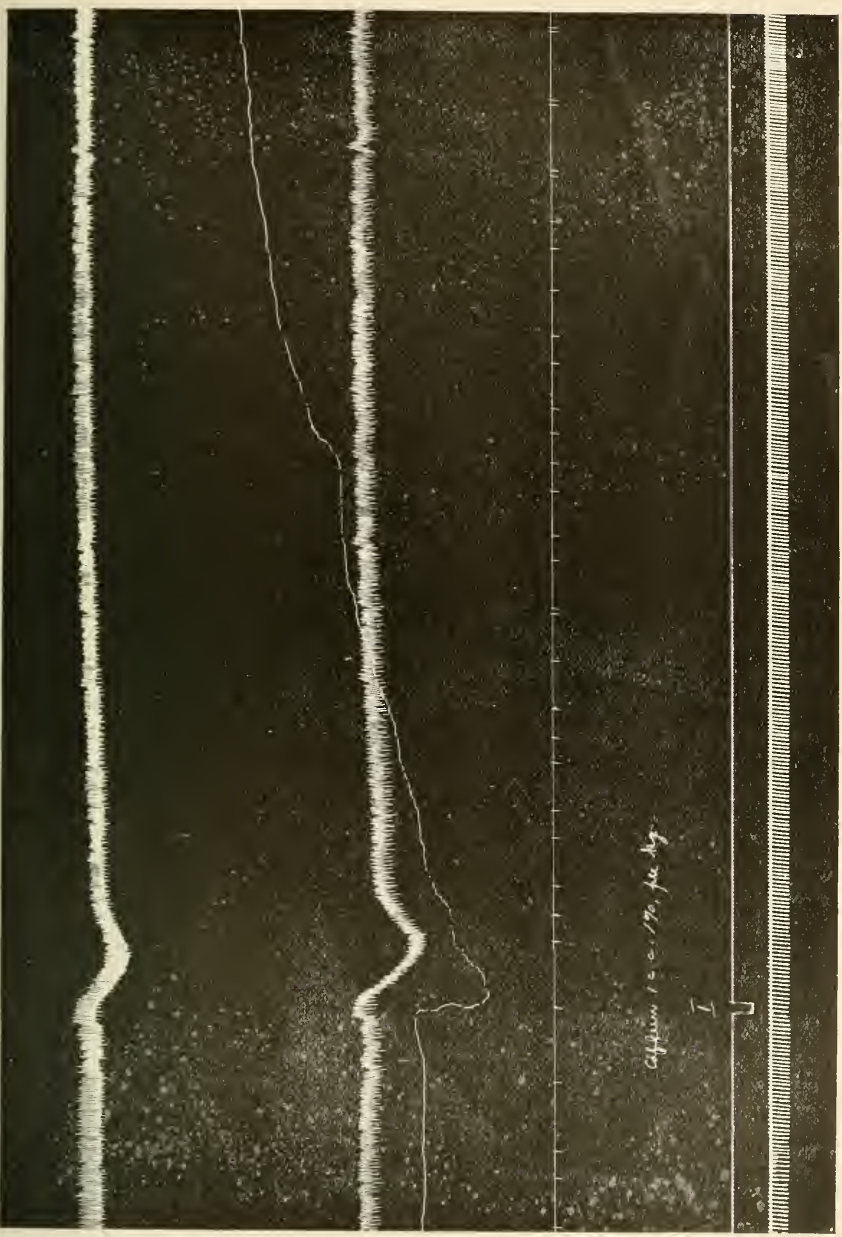
The caffein and adrenalin solutions were given to the animals intravenously, the femoral vein being employed for the purpose.

A canula was placed in the right ureter and the flow of urine recorded in the usual way on the tracing.

THE VASCULAR RESPONSE OF THE KIDNEY IN ACUTE URANIUM NEPHRITIS

The vascular response of the kidney nephritic from uranium has been studied in nineteen animals. Thirteen of the animals have been anesthetized by Gréhant's anesthetic in 60 per cent strength, while the remaining six animals have received morphine ether.

As a result of the effect on kidney function of the nephrotoxic substance plus the effect of the anesthetic there are three groups of animals in which the response of the kidney



TRACING 1, EXPERIMENT 3, TABLE 1

The figure represents from above downward the tracing from the Hurthle manometer, carotid blood pressure, kidney volume, signal magnet and time marker. The animal remained diuretic following Gréhant's anesthetic. Associated with the kidney vessels from caffein there was an increase in urine flow.

vessels and the influence of this response on diuresis, should be studied.

Group I (table 1) includes those animals which following Gréhant's anesthetic have remained diuretic.

Group II (table 2) includes those animals which following Gréhant's anesthetic have become anuric, while Group III (table 3) represents those animals which following morphine-ether have remained diuretic.

As will be seen by referring to the different tables which are to follow, there are animals in Group I and in Group III which are diuretic at the beginning of the experiment, but later developed an anuria. The explanation for the gradual development of an anuria which is illustrated by these animals will be considered in the general discussion of the experiments.

All of the animals in the different groups received the same quantity of uranium nitrate per kilogram. The study of the vascular response of the kidney was commenced in each experiment forty-eight hours after the initial uranium injection. The duration of the action of the nephrotoxic substance was, therefore, the same in all of the experiments.

All of the animals of the different groups were diuretic on the day of the experiment.

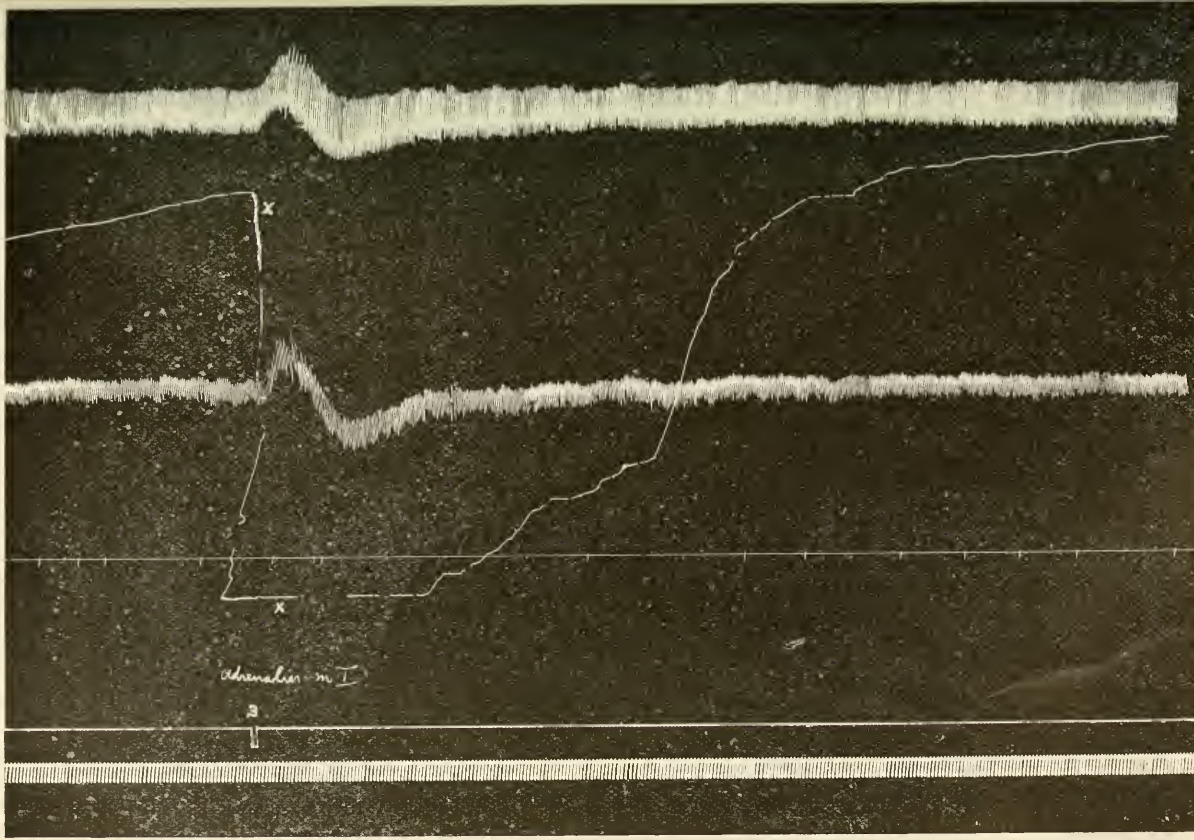
Group I. Control Experiments

Gréhant's anesthetic. The animals in this group were either young adult animals or puppies varying in age from four to seven and one-half months.

Following Gréhant's anesthetic in 60 per cent strength all of the animals with one exception remained diuretic. The animal which served as the exception became actively diuretic caffein (experiment 6, table 1).

The members of this group have shown a vascular response from caffein which varied between a minimum vasodilation of +32 mm. to a maximum vasodilation of +89 mm. (tracing 1, table 1).

In all of the experiments, with one exception, following



TRACING 2

The tracing is from the same animal as tracing 1. Adrenalin was given at the height of the caffein vasodilation to ascertain the effect of an exaggerated vasoconstriction on urine flow. With the marked vasoconstriction from adrenalin the flow of urine was decreased. With the vasodilation which followed the adrenalin constriction the flow of urine increased. At the points on the tracing indicated by x, the lever of the piston recorder was readjusted to the drum.

a vasodilation from caffein there was an increase in the flow of urine.

The degree to which the flow of urine is increased is apparently not dependent upon the degree of vasodilation (experiment 6, table 1) serves especially well to illustrate this point. Early in the experiment a vasodilation of +32 mm. increased the flow of urine twelve drops per minutes, while later in the experiment a vasodilation of +81 mm. had no effect in establishing a urine flow.

In this group of diuretic animals (Group I) a decrease in the flow of urine has resulted from the vasoconstrictor effect of adrenalin when this action was sufficiently pronounced (tracing 2).

The degree of vasoconstriction has varied between a minimum of —30 mm. to a maximum of —76 mm. A decrease in kidney volume of —68 mm. reduced the flow of urine eight drops per minute, a decrease of —72 mm. seven drops per minutes, while a vasoconstriction of —30 mm. failed to affect the flow of urine. The flow remained constant—five drops per minute both before and after the constrictor effect from adrenalin.

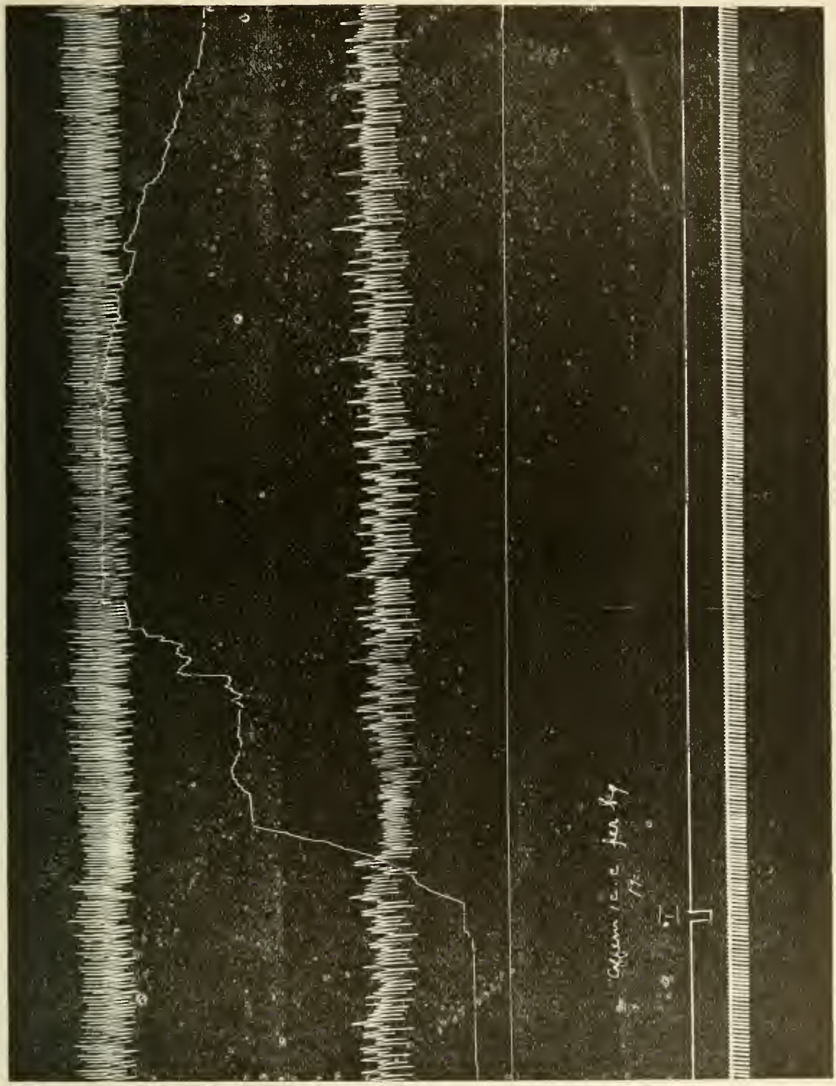
Group III. Control Experiments

Morphine-ether anesthesia. The animals of this group were either puppies or full-grown dogs. All of the animals were deeply anesthetized. Following the anesthetic all of the animals remained diuretic.

The effect of caffein and of adrenalin in this group of animals was very similar to the effect obtained in the previously described group of control animals in which Gréhant's anesthetic was employed.

The effect of caffein was to induce a vasodilation of the renal vessels accompanied by an increase in kidney volume varying between the limits of +37 to +87 mm. (tracing 5, table 3).

Following the vasodilation there was with one exception an increase in the flow of urine. Again in this group of experiments it will be seen that the degree of vasodilation is ap-



TRACING 3. EXPERIMENT 1. TABLE 2

The tracing is from an animal anuric following Gréhant's anesthetic. The tracing shows the renal vessels to be responsive to caffein. The vasodilation had no effect in establishing a flow of urine.

parently not the sole factor which determines the degree of diuresis. In experiment 6, for instance, a vasodilation increasing the kidney volume +87 mm. does not increase the flow of urine. The flows of urine was one drop per minute both before and after the injection of caffein. In experiment 2, however, with a rise in kidney volume of only +38 mm. the output of urine per minute was doubled; the urine flow increasing from 9-18 drops per minute.

When adrenalin was employed in the animals of this group it invariably induced a vasoconstriction of the renal vessels and a decrease in kidney volume (tracing 6).

The degree of vasoconstriction varied from a minimum response of —18 mm. to a maximum response of —60 mm. The effect of the vasoconstriction was either to reduce the flow of urine or to cause a temporary stoppage of urine flow. The most marked effect from adrenalin in reducing the flow of urine occurred in the experiments in which the maximum constrictor effect from adrenalin was obtained (experiment 2, table 3).

In this experiment a fall in kidney volume of —60 mm. was obtained from adrenalin, and the flow of urine was reduced from 18 drops per minute to 6 drops per minute.

Group II. Anuric Animals

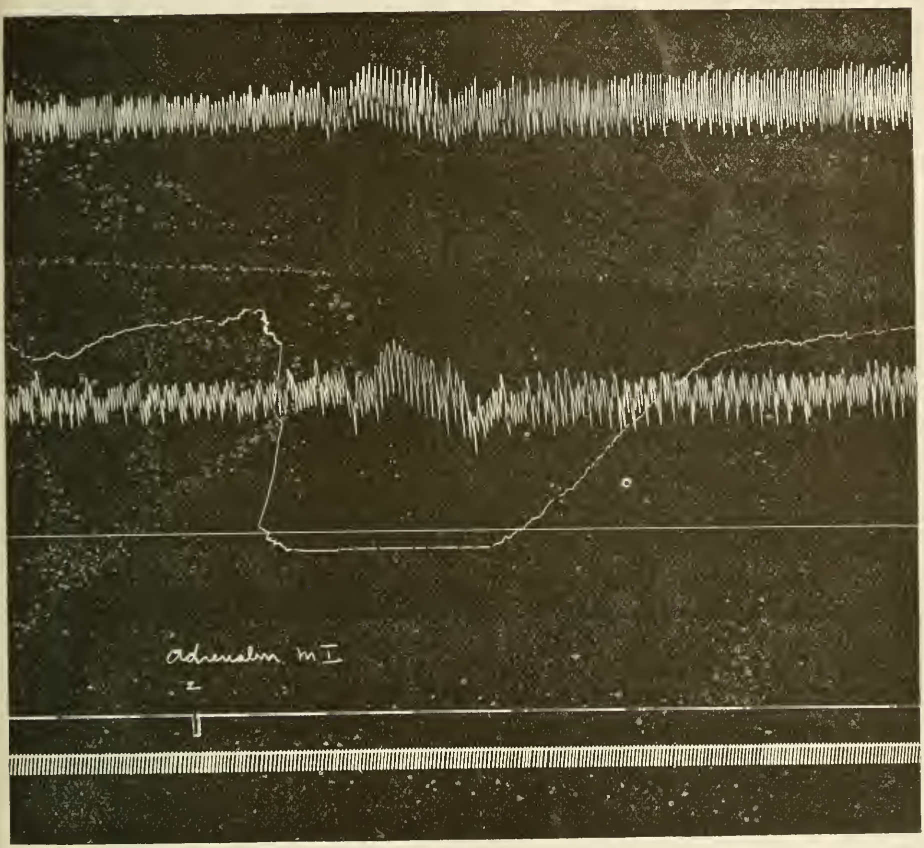
Gréhant's anesthetic. Seven full grown animals were used in this group. All of the animals were diuretic on the day of the experiment.

Followign Gréhant's anesthetic in 60 per cent strength all of the animals of this group became anuric and remained anuric throughout the experiments.

The renal vessels were responsive to the dilator effect of caffein (tracing 3).

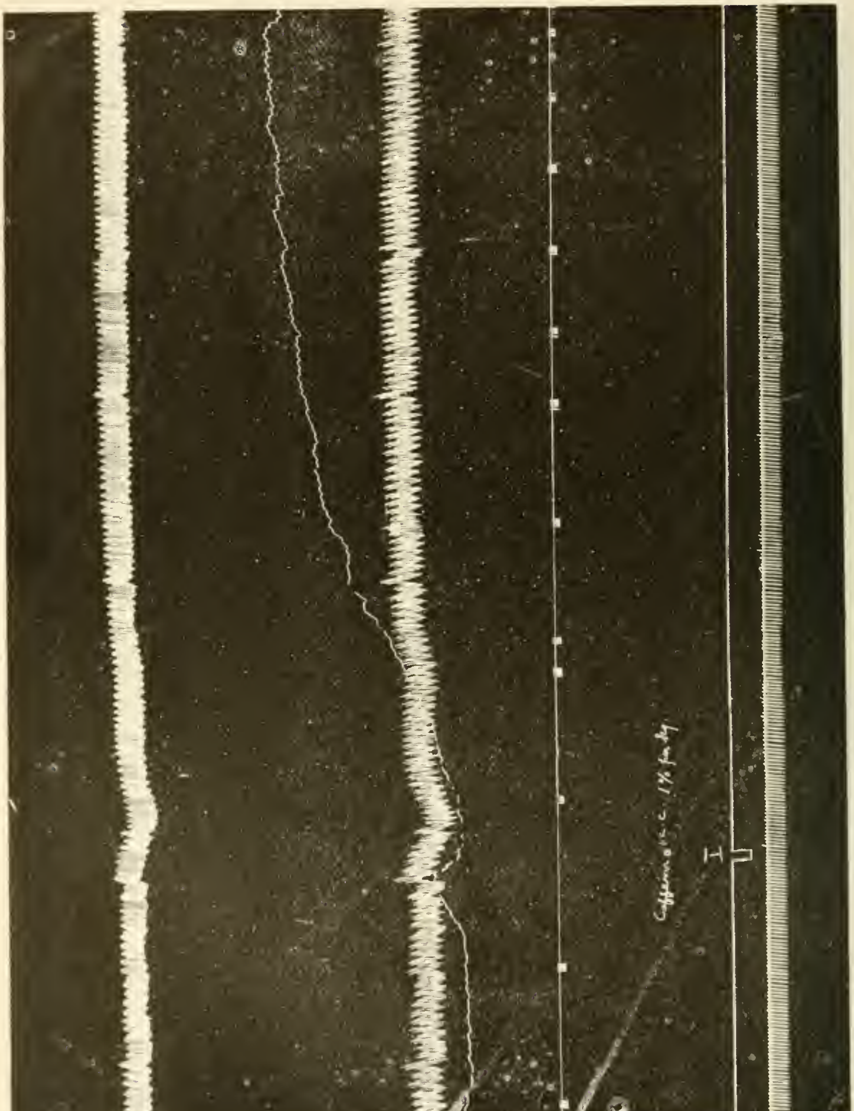
The degree of vasodilation varied between a minimum response of +17 mm. to a maximum response of +93 mm. In none of the experiments was the vasodilation associated with the establishment of a flow of urine (table 2).

In this group adrenalin induced a vasoconstriction and



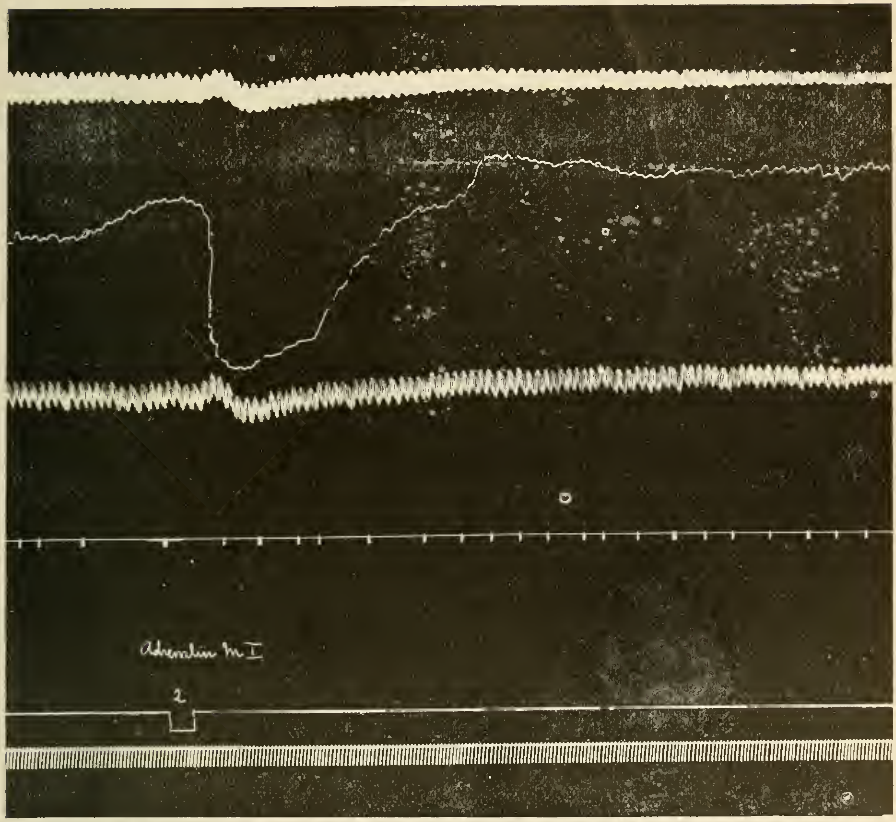
TRACING 4. EXPERIMENT 1, TABLE 2

The tracing is from the same animal as tracing 3. The tracing shows that the reneal vessels in the anuric animal are responsive to adrenalin. At the lowest point of the tracing which indicates the kidney volume, the lever of the piston recorder had reached its limit in downward excursion. The tracing shows that the renal vessels were responsive to adrenalin but does not indicate the degree of responsiveness.



TRACING 5. EXPERIMENT 1, TABLE 3

The tracing is from an animal that remained diuretic following morphine-ether as an anesthetic. Caffein induced but little effect in the heart volume or general blood pressure curve. Following caffein there was the usual dilatation of the renal vessels and a rise in kidney volume. The flow of urine was increased.



Tracing 6. Experiment 1, Table 3

The tracing is from the same animal as tracing 5. Following the decrease in kidney volume from adrenalin there is a transitory slacking in urine flow. The effect is comparable, though to a less extent, to the result shown in tracing 2. With the increase in kidney volume following the adrenalin constriction the flow of urine increases. The decrease in the excursions of the writing pen of the Hurthle manometer are due to a partial obstruction by a clot in the connection leading to the manometer.

fall in kidney volume varying between the extremes of —16 mm. to —72 mm. (tracing 4).

From the brief summary which has been given of the vascular response of the kidney in these different groups of animals and from a survey of the accompanying tables it will be seen that the vascular response of the anuric group of animals (Group II, table 2) to both caffein and adrenalin is comparable in its degree to the vascular response which has been obtained from these substances in the control group of animals (Groups I and III).

In the control groups, with two exceptions, a vasodilation from caffein has been accompanied by an increase in the flow of urine, while in the anuric group (Group II) a vasodilation as great or greater than the vasodilation obtained in the above mentioned groups has had no effect in establishing a flow of urine.

It would, therefore, appear that the condition of anuria is not dependent upon any lack of response on the part of the renal vessels and also that diuresis from caffein is dependent upon some mechanism in the kidney other than a responsive vascular mechanism.

THE PATHOLOGY OF THE KIDNEY IN ANIMALS NEPHRITIC FROM URANIUM WHICH FOLLOWING AN ANESTHETIC EITHER REMAIN DIURETIC OR BECOME ANURIC

When the animals which have been employed in the previously discussed experiments are classified from the standpoint of the pathological changes developing in the kidney, the animals in Groups I and III which have remained diuretic following the different anesthetics are found to present a pathological response which in general is similar; while those animals which have become anuric, Group II, show changes in the kidney of the same character but of sufficient difference in degree to separate them from the diuretic groups of animals.[2]

[2] A detailed account of the pathology of the kidney in animals either anuric or diuretic, following different anesthetics will be found in the Jour. Med. Research, xxviii, 3, 1913.

The vascular pathology of the kidney in both the diuretic and anuric animals consists primarily in an acute congestion which is most marked at the glomerulus. The glomerular capillaries are engorged with blood and fairly uniformly fill the space enclosed by the capsule. Occasionally between the capillary tufts and the capsule there has been observed a small quantity of granular material. This has never been present in such an amount as to compress the capillaries. Blood cells have not been demonstrated in this material.

The capillaries have failed to show any histological evidence of changes of a degenerative character. The interesting type of vacuolar degenration of the capillary walls, first described by Christian (5), has not been present in this series of animals. Neither have the more extensive structural changes been observed which have been described by Chris-

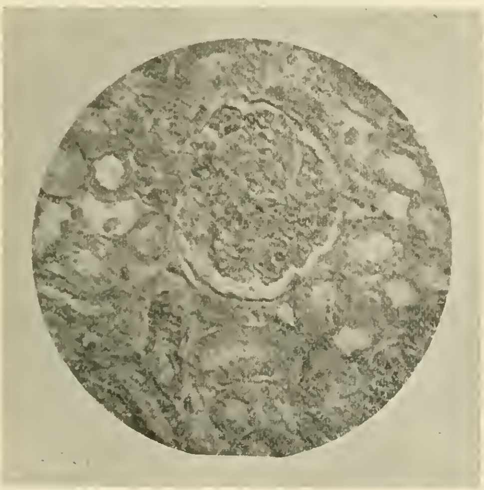


FIG. 1. EXPERIMENT 3, TABLE 1

The figure shows the absence of acute swelling of the epithelium. The epithelium is not necrotic. The lumen of the tubules is not encroached upon by the epithelium. The glomerular vessels are engorged with blood and fairly uniformly fill the capsular space. The renal vessels were responsive to peripheral stimuli. The figure represents the kidney of an animal that remained diuretic following Gréhant's Anesthetic.

tian and O'Hare (6) as occurring in the glomeruli of rabbits, nephritic from uranium. In a later communication by O'Hare (7) the relative difficulty is shown of inducing in the dog glomerarular lesions of a degenerative character.

The point of difference which serves to separate pathologically the diuretic from the anuric animals consists in the difference in the degree and extent to which the epithelium of the kidney has become involved.

FIG. 2. EXPERIMENT 1, TABLE 2

The figure represents the kidney of an animal anuric following Gréhant's Anesthetic. The epithelium of the tubules shows extensive necrosis. The lumen of the tubules have become obliterated by the swollen epithelium. The glomerular changes are similar to those shown in Figure 1. The renal vessels were responsive to peripheral stimuli.

In those animals which are found in Groups I and III that remain diuretic following an anesthetic the degree of epithelial damage is slight (figs. 1 and 3).

The epithelium of the convoluted tubules is histologically well preserved. Both the cytoplasm and nuclei of these cells stain well. The cells either show no swelling or the degree of

swelling is slight. Vacuolation of the cytoplasm which is such a constant and marked feature in the epithelium of the anuric group is rarely present.

Henle's loop tubules, and especially the ascending limb of Henle's loop contains a small amount of fat.

The epithelial involvement in the diuretic animals (Groups I and III) is most marked in those animals which either have a comparatively slight flow of urine or that during the course of the experiment become anuric (experiment 6, Group I, table 1; experiment 6, Group III, table 3). In such animals the epithelium of the convoluted tubules shows

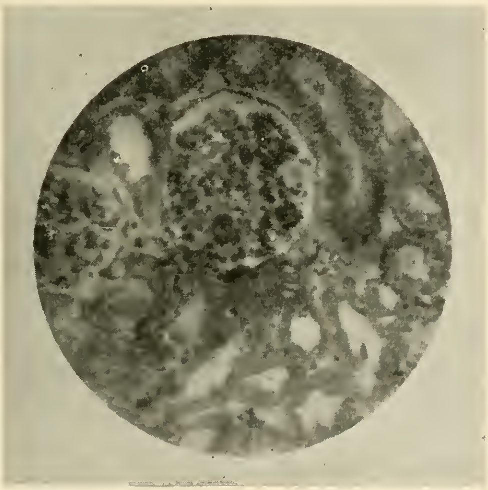


Fig. 3

The figure represents the kidney of an animal which remained dieuretic following morphine-ether. The epithelium is not necrotic and shows only a slight degree of swelling. The histological changes are comparable to those changes seen in Figure 1.

both swelling and vacuolation, while the epithelium of tubules deep in the cortex occasionally show areas of necrosis. Such areas are small and limited to a few tubules.

In the anuric group of animals (Group II) the epithelium becomes actually swollen and vacuolated and the swollen

cells either greatly encroach upon or occlude the lumen of the tubules. The vacuolation usually first appears in the zone just around the nucleus and later not infrequently takes the place of the nucleus. The vacuoles are not fatty in nature. These are the initial changes. The epithelium of the tubules deep in the cortex and of the convoluted tubules undergoes a rapid necrosis. The swelling and necrosis may be of a most severe grade (fig. 2), and involve all of the tubules of the labyrinth excepting the junctional and collecting tubules. These tubules are not usually involved in the necrotic process.

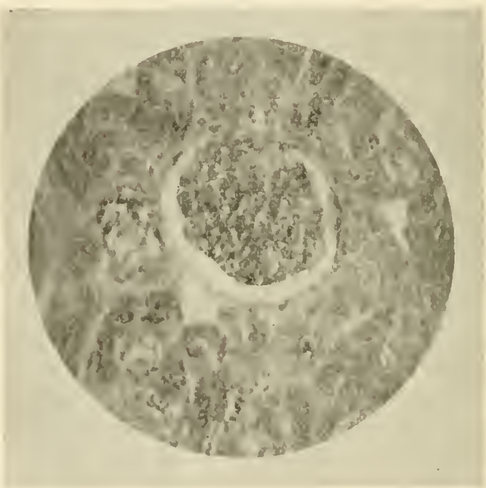


FIG. 4

Figure 4 represents the kidney of an animal nephritic from uranium nitrate. The nephrotoxic substance was given in the usual dose of 6.7 mgs. on two successive days. The kidney was removed under light ether anesthesia. The animal was freely diuretic. The epithelium is not necrotic. The lumen of the tubules have not been encroached upon by any marked swelling of the epithelium.

The above mentioned changes are remarkable not only on account of their wide spread nature and severity, but on account of the rapidity with which they develop.

The tubules of the loop of Henle contain large amounts

of fat. The fat, when stained by Herxheimer's Scharlach R method, appears in the form of coarse granules or large masses.

In Groups I and III there are animals which after an initial period of diuresis become anuric (experiment 6, Group I, table 1 and experiment 6, Group III, table 3). These animals have shown a vascular response to both caffein and adrenalin, which in degree is comparable to the vascular response of animals in the same groups that remained diuretic. They differ, however, from the diuretic members of the group in that the degree of epithelial involvement of the

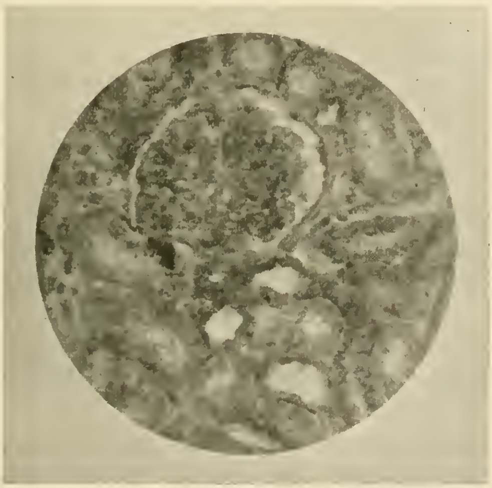


FIG. 5

Figure 5 represents the remaining kidney of the same animal after the animal had been subjected to Gréhant's Anesthetic for one hour. The epithelium is severely swollen and shows an extensive necrosis. As a result of these changes the lumen of the tubules has become obliterated. The animal was completely anuric.

Figure 4 should be compared with figures 1 and 3, and figure 5 with figure 2.

kidney is much more pronounced than it is in those members remaining diuretic.

It would appear, therefore, that the gradual development

of an anuria is more dependent upon the extent to which the epithelial element of the kidney becomes damaged than upon any lack of response upon the part of the renal vessels.

This observation has been confirmed in the following way. Six animals have been rendered nephritic by the usual amount of uranium. One kidney which serves as a control (fig. 4) has been removed under very light ether anesthesia. The animals were then given Gréhant's anesthetic in the usual amount. When the flow of urine had been greatly reduced, or an anuria had developed, the remaining kidney was removed and studied histologically in comparison with the control kidney (fig. 5).

By employing such a method it was found that associated with any decided and continued reduction in the flow of urine which was not increased by a rise in general blood pressure or by a vasodilation of the renal vessels from caffein, the epithelial element of the kidney showed the same type of degenerative change which had been found in the group of animals that were anuric from the commencement of the experiment (Group II, table 2) and the same type of changes which had developed in those animals of the control groups (Groups I and III) that late in the experiment became anuric.

In conclusion; the anuric and diuretic groups of animals show no changes in the vascular element of the kidney which will serve to differentiate them histologically. The essential pathological difference between the two groups lies in the difference in the degree and extent of the involvement of the epithelial element of the kidney.

The epithelial damage in the diuretic animals is slight; in the anuric group it is extensive.

DISCUSSION

It has been shown in the animals which have been used in the present investigation that the renal vessels remain responsive to stimuli which either lead to their dilatation with an increase in kidney volume or to their constriction with a decrease in kidney volume.

The degree of this response in the animals of the different groups, and in the animals of the same group varies. As a result of these variations it is difficult to say that the animals in one group are more responsive to these stimuli that are animals in another group. It is, however, clearly demonstrated by the control groups of nephritic animals (Groups I and III) that following a vasodilation from caffein which may be as low as +32 to +37 mm. an increase in the output of urine takes place; whereas in the anuric group of animals (Group II) with vessels responsive to the same stimulus, and giving a vasodilation which may be much greater than that recorded above, +63 and +91 mm., no flow of urine takes place.

The experiments which have been conducted in this investigation, in addition to the experiments which have been referred to in former investigations (1 and 2), would indicate that the vascular mechanism of the kidney in an animal nephritic from uranium and anuric following an anesthetic, is as responsive to caffein and adrenalin as is the vascular mechanism of the kidney of an animal nephritic from uranium which following an anesthetic remains diuretic.

The conclusion seems clear that the acutely developing anurias in uranium nephritis which may follow the use of different anesthetics are not dependent upon any loss in irritability on the part of the renal vessels.

In the investigation by Pearce, Hill and Eisenbrey (4) which has been previously referred to, the authors have pointed out the effect of an anesthetic in inducing an anuria and have also shown that the ability of the renal vessels to dilate is retained. The phenomenon of vasodilation with little or no diuresis they attribute to an impermeability of the glomerulus which follows the anesthetic.

In the present investigation the changes in the kidney which have been constantly associated with the development of a complete anuria, and the changes which develop in the kidneys of those animals that at the commencement of the experiment are diuretic but that later become anuric, have

consisted in degenerative changes in the epithelium of the tubules and principally in the epithelium of the convoluted tubules. These degenerative changes which may, or may not be associated with an acute swelling of the epithelium, terminate in necrosis.

CONCLUSIONS

1. When caffein is given to an animal nephritic from uranium with an epithelial element histologically intact, following a rise in kidney volume from the vasodilation induced by the caffein there is an increase in the flow of urine.

2. When however, caffein is given to an animal nephritic from uranium with an epithelial element which is in various stages of necrosis, there is no change in the rate of urine flow even though the vascular response from the caffein may be as great as or greater than the vascular response in the animals in which the caffein was of diuretic value.

3. From the observations which have been made in the present investigation it would appear that the functional capacity of the kidney nephritic from uranium is more dependent upon an intact epithelial element than it is upon a responsive vascular mechanism.

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NOTES ON NEW AND RARE SPECIES OF FUNGI FOUND AT ASHEVILLE, N. C.

BY H. C. BEARDSLEE

The State of North Carolina seems to be very rich in its fungous flora. The great variety of conditions found within our borders give ample room for a large number of species of these interesting plants, many of which appear to be rare in the United States, while not a few seem to be new to science.

The following notes have been selected from the writer's accumulation during the past twelve years as of possible interest to those in our state who are interested in these difficult and puzzling plants. All of the species discussed have been found near Asheville, and will doubtless be found quite generally in at least the western part of the state.

Lepiota floccosa sp. nov.

Pileus 2-5 cm. broad, at first campanulate, then expanded and obtusely umbonate, thickly covered with a soft, smooth, appressed tomentum, which is brown and at first continuous, then broken into appressed scales with the lighter context showing between. Margin thin, extending beyond the lamallae in a soft cottony margin.

Lamellae pure white, crowded, narrow, free.

Stipe pure white, thickly covered with white fibers which are at first attached to the margin of the pileus, and form a thick annular zone toward its summit.

Spores broadly elliptic 6-8 by 3-4 mc.

This species has been observed for several years. In appearance it is much like *L. clypeolaria,* but the spores are absolutely different. It has some of the characteristics of *L. acutesquamosa* Weim., but is amply distinct from it. It has the pileus always smooth and never shows the slightest trace of the acute scales which mark this latter species. The thick mass of white fibers which clothe the stipe is very characteristic and will at once distinguish it. Bresadola, whose

thorough knowledge of the Agarics is well known, says it is unknown in Europe. I find it each year in deep woods.

Lepiota parva sp. nov.

Pileus 6-12 mm. broad, thin, campanulate, then expanded and nearly plane with a rounded umbo, delicately tomentose, striate on the margin.

Lamellae pure white, rather distant from the stipe, crowded, very narrow.

Stipe slender, pure white, glabrous, 1-3 cm. long.

Annulus persistent, rather small. Spores 5-6 by 3-4 mc.

Growing in moss and on bare ground in woods.

This dainty species is closest to *L. parviannulata* of Europe. I find it frequently in colonies. It is a very delicate and distinct species.

Lepiota caerulea sp. nov.

Pileus 10-15 mm. broad, campanulate, then expanded and umbonate, blue gray, with the umbo darker, marked with dark, appressed fibrils, striate on the margin.

Lamellae flesh color, ventricose, free, thin, crowded.

Stipe slender, 2-3 cm. long, glabrous, white.

Spores ovate, apiculate 4-5 by 2-3 mc.

The peculiar blue-gray color of the pileus, with its small size and minute spores mark this species. It is not common but is found every year.

Two other species of Lepiota occur at Asheville which are possibly worthy of note, are withheld for the present. One which I call *L. brunnea* in my notes is much like Peck's *L. fuscosquamosa* but is uniformly only a fraction of its size. I find it from 5-8 mm. broad while Pecks's species is 2-5 cm. broad. This seems too great a difference to be reconciled, but the fact that the spores are about the same in the two species makes me hesitate.

Cortinarius robustus sp. nov.

Pileus as much as 14 cm. broad, very solid and firm, dull date brown, the paler margin thinner and inflexed, becoming expanded with maturity, viscid when moist, flesh firm, blue when moist, becoming white in drying.

Gills at first violaceous, then pallid, finally cinnamon, the violaceous tint persisting under the inflexed margin, adnate, irregular on the margin.

Stipe solid, firm, rather short, slightly violaceous, fibrillose to the point where the incurved pileus touches it, pubescent above that.

Spores 9-10 mc. long.

This is the largest and firmest species of Cortinarius that I find at Asheville. It belongs to Phlegmacium but seems distinct. I find it in large colonies under oaks. The stipe is only slightly bulbous in my specimens and never marginate.

The Carolina Cortinarii are quite numerous and very perplexing. Many of Peck's New York species occur in our mountains, along with some species which appear to be rare farther north. *Cortinarius balteatus,* of which I find no record in the United States, occurs with us occasionally, and is one of our finest species.

Boletus carolinensis sp. nov.

Pileus bright golden yellow, 5-8 cm. broad, viscid, staining the hands yellow, hemispherical, then expanded, and sometimes depressed at the center, margin thin, at first incurved.

Tubes at first white or nearly so, then yellow flesh color, mouths round, thickly covered with yellow glandular drops, which give them a yellow color.

Stipe colored like the pileus, but a little lighter, viscid, pruinose under a lens, often tapering downward, sometimes becoming hollow.

Spores ochraceous tan, 10-12 mc. long, appearing bright yellow under the microscope.

In lawns under oaks. Not common.

This is our most brilliant yellow species. I know no species which is very close to it. It is unusually viscid and the hands are stained in handling it. The tubes appear stuffed when young. The flesh is firm and white. The spore color is close to Ridgway's Mars yellow.

Volvaria cinerea sp. nov.

Pileus 1-2 cm. broad, gray or bluish gray, soon plane, with a small rounded umbo, clothed with long, dark, appressed fibrils, striate on the margin.

Gills rounded behind, remote from the stipe, white, then flesh color.

Stipe white, solid, fibrillose.

Volva dark colored, splitting into three or four divisions.

Spores 5-6 mc. long, broadly elliptic.

Growing on rotting logs of deciduous woods.

Our species of Volvaria are few in number and are rare. So far I have found but three species at Asheville. Each year I find *V. parvula* Weim. growing in flower beds under weeds. This is a very dainty species scarcely 1 cm. broad, pure white, and umbonate.

The third species is *V. pubescentipes* Pk. which is also *V. hypopitya* Fr. This is found usually growing on old leaves and is pure white with its pileus usually 4-6 mm. broad.

The following species occur at Asheville, though I find no record of their detection in other parts of the United States:

Tricholoma saponacea Fr.

This is occasionally found in the fall in oak woods. It has a curious soapy odor as it dries and the flesh and lamellae tend to turn red when injured. Bresadola has seen both my specimens and photographs and positively identifies them as this species.

Inocybe corydalina Quel.

This is one of our most interesting species of Inocybe. The pileus is white and of good size (3-7 cm. broad). It becomes more or less brown with age. The gills are pure white, then cinnamon, and the spores smooth. The flesh is white and becomes red when cut, especially in young plants. It has a peculiar odor which is very pronounced. Those to whom I have submitted it here compare the odor to that of Sandal Wood. This species seems to be closely related to *I. pyriodora* and as a matter of fact my plants seem to have part of the characters ascribed to both species, the reddening of the flesh is more suggestive of *I. pyriodora* than of *I. corydalina* but the odor is not at all that of fruit. Bresadola has seen and verified my specimens.

Hygrophorus calyptraeformis B. and Br.

Of all our Hygrophori this is the most attractive species. I find it in only one station. It is a beautiful rose pink in color and the thin pileus is acutely umbonate and split into recurved lobes. It is exactly in accord with Cook's figure. It is so striking that it must be rare as I find no record of its occurrence.

Two species of Crepidotus, *C. calolepis* Fr. and *C. mollis* Fr., are also not rare at Asheville. These are usually referred to *C. fulvotomentosus* Pk. and *C. haerens* Pk. The original description of *C. calolepis* does not well fit our plant, which accounts for the failure to recognize it.

It may be said, however, that the discrepancies are just as marked in the case of the Swedish plant. I found in 1905 abundant material of Frie's species in one of his old collecting grounds in Sweden and found it identical with our own plant. The same may be said of *C. mollis.* This species is viscid and has a peculiar gelatinous context, and a separable cuticle. Both our plant and those found in Sweden have these peculiarities and seem not to be different in any essential character. One who has seen both growing will have little doubt that our plant is the same as Fries' species.

ASHEVILLE, N. C.

THE INFLUENCE OF RADIUM RAYS ON GERM CELLS AND EMBRYONIC TISSUES*

BY W. C. GEORGE

Since 1910 there have been some valuable contributions to our knowledge of the influence that radium rays exert on animal tissues. Perhaps the most important of these is Oskar Hertwig's paper entitled *Radiumkrankheit Tierischer Keimzellen,* which I have had occasion to read in the course of some of my own investigations in regard to the effects of various changes in the environment on the development of embryos. The results recorded in this paper together with some later results obtained by Oskar Hertwig, his son, Gunther Hertwig, and others, will constitute the basis of my remarks this evening, in which I shall attempt to give you a conception of the present status of our understanding of the biological effects of radio-activity.

But before proceeding with a consideration of the later discoveries, it would probably be of value to review the discoveries made before 1910. Soon after the discovery of radium in 1908 by Mme. Curie, biologists began to study the influence that Rontgen and radium rays exercise upon animal cells that they strike. The experimenters who studied the influence upon animal cells may be divided into two groups. Those of the first group examined the effect of radiations upon the male and female sex cells. To this group belong Bohn, Perthes, Schwarz, Schaper, Levy, Bardeen, and others. All of these workers came to the conclusion that radium rays exercise a retarding and injurious effect upon the embryonic processes. Schwarz and Schaper attempted to explain the effect of radium rays by the decomposition of lecithin in the living cell. The American investigator, Bardeen, working with amphibian eggs, found that the period of greatest susceptibility is the period during which there is the most rapid production of nuclear material.

*Read before the Medical Society of the University of North Carolina, October 16, 1915.

The investigators in the second group studied the effect of the radium rays upon the different tissues of the more or less advanced organism. Seldin, Birch-Hirschfeld, Werner, Heinecke and Thies, Ragaud and Dubreuil, Bergonié and Tribondeau, Aubertin, Delamare and Beaujord, Guyot, Schumann, Lidenborn, and London are some of the workers in this field. They found that all tissues are sensitive to radium rays, but to a varying degree. In general cells appear to be sensitive to radium according as they have the character of germ cells and have the tendency to increase through rapid cell division. Two kinds of tissues are particularly affected: (1) male and female gonads with the eggs and sperm; (2) blood and lymph with the related spleen, lymph glands, etc. The chromatin of the cell nucleus is affected injuriously and finally the nucleus will be destroyed. As a result of the discoveries of the workers in this field Rontgen and radium rays have found an application in the treatment of rapidly growing structures, such as cancers and tumors.

As previously stated, the study of the action of radium has been pushed for the past few years by Oskar Hertwig, director of the Anatomical-Biological Institute of the University of Berlin. In 1909 he began and has since continued a series of experiments on the influence of radium rays on the development of amphibian embryos. He ran two series of experiments. In his A-series fertilized frog eggs were irradiated for various lengths of time, from five minutes to four hours. Only those eggs radiated for a short time (5-15 minutes) developed beyond the very early stages. Those subjected to a longer or stronger radiation did not pass beyond the blastula stage, where they died.

The B-series consisted of experiments in which sound eggs were fertilized with sperm radiated for various lengths of time from five minutes to twelve hours. He obtained a great variety of abnormalities which have considerable bearing on general embryological theories. We shall not consider that side of his results, however, but shall confine ourselves

to the biological effects of radio-activity. Hertwig found that the effects of the radium depend upon the strength and duration of the radiation. The effect of five minutes radiation of the sperm was clearly recognizable in the resulting embryo. Radiation of longer than five minutes always has a worse result until a certain low point is reached. This falls with increased radiation up to one hour. From here on the developmental curve begins to rise with increased radiation. Six to twelve hours radiation of the sperm produces astonishingly pretty normal embryos.

What action have the radium rays upon the sex cells to account for the results? Schwarz's and Schaper's Lecithin Hypothesis, i. e., that the injurious effect is due to the decomposition of lecithin, is insufficient. The lecithin hypothesis has not been established by chemical analysis, and it does not explain the results of fertilizing sound eggs with sperm radiated different lengths of time. Sperm radiated for five minutes cause very abnormal development, and in this case a very small amount of destructive products of lecithin would be added to the relatively immense mass of the egg.

Hertwig's theory is that by radiation with radium the nature of the germ cells as living organisms is altered (made pathological). In eggs fertilized with radiated sperm we have a fusion of a sound and a pathological germ, and the sick germ, the chromatin being chiefly important, acts as a *contagium vivum* (an infectious *bacillus*). It causes abnormal development because in fertilization the pathological male chromatin fuses with the egg nucleus and in all future mitoses this pathological chromatin increases and is distributed to all the cells. In eggs radiated after fertilization we get more abnormal embroyos because both maternal and paternal chromatin is made radium sick. That the protoplasm does not suffer so much injury as the chromatin seems to be shown by the fact that the sperm loses its motility only after very long and intense radiation.

Why, after passing a certain point, does increased radiation result in improvement in development? This is explained on the assumption that the degree of abnormality depends not only on the degree of injury to the chromatin but also upon its power to increase and divide so that all cells will be affected by the radium sick chromatin. After passing a certain point the power of the paternal chromatin to increase and divide becomes less or becomes wholly lacking. If the chromatin loses its power to increase after prolonged radiation then a real fertilization in the sense of a fusion of equal maternal and paternal germs no longer occurs, and the development of the egg assumes the character of parthenogensis. Fertilization, where the power of the chromatin to increase is wholly lost, is only a developmental stimulus.

That the eggs of vertebrates generally may have the power to develop parthenogenetically seems to be shown by Bataillon's experiments on the frog eggs and by Lacaillon's discovery that bird eggs sometimes start development naturally without having been fertilized. Bataillon caused frog eggs to develop without fertilization by pricking them with a fine platinum needle. His experiments have been repeated by Dr. Bancroft, of the Rockefeller Institute, in our own laboratory, and also by MacClendon of this country, by Dehorne and Henneguy of France, by Brachet and Herlant of Belgium, and by Levy of Germany. And so it is now a well established fact that the frog egg has the power to develop parthenogenetically. From some of the later investigations, however, it now appears that for the frog egg to develop beyond the very first stages, something more than a puncture is necessary. A blood or lymph cell, or at any rate some solid element derived from the blood or lymph, must be introduced into the egg cytoplasm. This calls to mind that an American, Guyer, before Bataillon's discovery, reported that he had succeeded in fertilizing frog eggs with blood and lymph. Guyer in interpreting his results, seems just to have missed the real fact that the egg itself under the influence of a stimulating agency starts to develop.

It has also been shown that the chromatin of a penetrating sperm may be eliminated from the developmental processes. Both Boveri and Teichmann have fertilized eggs of Echinus with sperm treated with potash solution, and though the sperm entered the egg and intiated development, the sperm nucleus did not fuse with the egg nucleus. Loeb and later Kupelwieser caused sea-urchin eggs to develop by adding sperm of Mytilus (a salt water mussel). The sperm entered the egg but the head of the sperm with its chromatin took no true part in the development.

Since first putting forth his theory that it is the chromatin that is chiefly injured by treatment with radium, the evidence in favor of it has been added to by further experiments by Hertwig, by his son Gunther Hertwig, and by Opperman. Oskar Hertwig has found in the larvae of Triton obtained from sound eggs fertilized with irradiated sperm, that the nuclei of the body cells have only half or the reduced number of chromosomes, the male chromosome complex having failed to take its part in development. Gunther Hertwig has shown that by intensive radiation of several hours duration sperm threads of the sea-urchin are so affected that though they are able to penetrate the egg and stimulate development, they lose their ability to form normal chromosomes and thus are eliminated from development. He also found that in frog eggs treated with radium and fertilized with normal sperm, the injury increases with the duration of the radiation up to a maximum and from there on decreases again as the radiation is prolonged—as his father found for sound eggs fertilized wits radiated sperm. Only the radiated nuclei show the effects of the treatment. In the frog then development is possible with only a haploid nucleus, i. e., only the half of the nucleus derived from one of the parents. Where the injury is severe to either the egg or the sperm nucleus, the other is able to carry on the development, and in fact there is less deviation from the normal course of development than in the case where both nuclei are injured only slightly. All of this evidence seems

to bear out Hertwig's conclusion that it is the chromatin of the cell that is chiefly injured by treatment with radium, and that when the injury is severe enough the damaged chromatin is eliminated and the egg develops parthenogenetically.

There has been some criticism of Hertwig's explanation of the action of radium on the ground that it does not go far enough back into the organization of the cell, and it is said that further explanation must ultimately be chemical in nature. Packard, and Richards who recently published an interesting article in *Science* on the biological effect of radio-activity, have sought to explain its influence by the effect that radium has on certain intercellular enzymes; but in the present state of our knowledge of biochemistry it cannot be said that we know anything about chemical processes that go on within the egg which can be regarded as the causes of differentiation, though further information of this nature is greatly to be desired.

CHAPEL HILL, N. C.

WINTER GRASSES OF CHAPEL HILL

BY W. C. COKER

Perennial Rye Grass (*Lolium perenne*).
Italian Rye Grass (*Lolium multiflorum=L. italicum*).

These two grasses can scarcely be distinguished from each other except in flower, and are so alike that we may treat them as one. They are short lived perennials in this state.

They may be distinguished by their deep green, shining leaves and bright-red or purplish-red leaf bases. They most resemble blue grass when young, but blue grass is not shining and lacks the red base.

Wherever lawn mixtures have been sown these grasses usually escape to the roadsides, walks, open places, and gardens, and there form one of the most conspicuous elements in our winter grass growth. They do not form a part of the old established lawns or pastures.

Rye grass is one of the constituents of most lawn mixtures, and we notice that in lawns here it is one of the three or four species that survive the first summer to any extent. It is also obvious that usually not one-tenth of the original stand goes through the summer. Of this remaining one-tenth the rye grass often forms almost one-half. The other half is mostly red top, sheep fescue or red fescue, and in shaded places blue grass.

The rye grasses germinate quickly and grow off rapidly and thus serve to give a green effect the first winter before the slower grasses have made much show. They begin to die out the first summer, and after two or three years are usually quite gone.

Low Spear Grass (*Poa annua*).

This odd little grass is what is called a winter annual, sprouting in fall and flourishing through the cold weather, then dying out completely at the beginning of warm weather. The exact time of its sprouting and dying depends entirely

on the weather. In the spring of 1914, which was quite dry, it disappeared before the first of June, reappearing again in September. In damp, cold springs it will live well into June. It is peculiar in its requirements, seeming to prefer hard, bare, open places and it does not mind being trampled by man or animals. It occurs on walks and road margins, in waste places and to some extent in lawns, as on the campus. The best turf of *Poa annua* in Chapel Hill is in front of the poultry houses and west of the cow barn on Glenn Burnie Farm. The turf it forms is exceedingly close and fine, and the growth is so short that it requires little or no mowing. If it would only last through the summer, it would make an ideal lawn. As it is, however, it is rarely planted, and the seed are hard to get in the trade. It is used to some extent to help the winter sod of putting greens, and would be fine in its season for terraces, grassed walks, courts, etc.

SWEET VERNAL GRASS (*Anthoxanthum odoratum*).

This is a strongly bunched, early maturing grass that is fond of cold weather and does most of its growing in winter and spring. By the middle of March it is 4-6 inches high, even in our colder winters, and it forms most of the first spring cutting in more shaded parts of the campus and in many of our shaded lawns that are not mowed often. In more open lawns and those that are mowed frequently it is scarce, apparently not liking the sun or the lawn mower. On account of its densely tufted habit it is not a desirable lawn grass, but for groves and parks and meadows where the mowing is not frequent or close it is an agreeable constitutent on account of its very pleasant vanilla odor when cut and also for its ability to stand much shade and make a green show in winter. We recommend it as one of the ingredients for sowing all shaded places not closely mowed.

KENTUCKY BLUE GRASS (*Poa pratensis*).

Blue grass is the best lawn grass to be had where it can be made to flourish. It does not like hot dry weather or poor soil, and we have to treat it with special care to entice it to

grow in our southern states. In this latitude its principal requirement is a rich soil, and next is shade and water in dry weather. It forms a deep green, dense, and permanent turf and is worth taking trouble to secure (see article, *The Lawn Problem in the South*, in this issue for treatment of blue grass). In Chapel Hill blue grass occurs spontaneously to a considerable extent in good soil by walks, roads, in orchards, open places, back yards, shaded lawns, etc. It makes very early growth in spring and by March it probably furnishes the greater part of the green grass growth that has appeared. In all well shaded lawns, such as in the Alexander Place, the McRae Place, the old Martin Place, etc., the blue grass is the principal grass and maintains itself without attention, but unless well shaded it must be watered in dry hot weather or it will disappear. Unless heavily shaded a very fertile soil is of prime importance with blue grass.

ORCHARD GRASS (*Dactylis glomerata*).

This large grass makes tall green tufts that are conspicuous by the last of March. It much prefers shaded places and is rather common in fertile soil by paths and roads and in waste places. It forms most of the growth in the low depression west of the old Mangum Place. It is not suited for lawn grass on account of the large separate tufts it makes, but is valuable for hay or grazing in open or shaded places. It was one of the three grasses sown on Glenn Burnie hills in the fall of 1912 and it has now become well established there and forms most of the forage. It hardly made any show the first summer as it is of slow growth at first.

TALL MEADOW OAT GRASS (*Arrhenatherum elatius*).

This was planted by me as one of the four constituents on my hillside hay fields at Glenn Burnie Farm. The others were Italian rye grass, orchard grass and red clover. The ground was gravelly clay and not very rich. The oat grass did not take very well and formed only a small part of the first summer cutting (1913). The Rye grass did much better and formed the bulk of the cutting. The orchard grass hardly showed up at all the first summer, but has since been

the principal ingredient of the hay. Clover did well in richest places only. The oat grass has now (Sept., 1915) almost disappeared from these fields, except on terraces and borders. It is not a persistent grass in this latitude and is not found on roadsides or other waste places.

Chess or Cheat (*Bromus secalinus*).

This is a vigorous spring grass that would make good grazing but as it is no better than a number of others for this purpose and as it is a bad weed in grain crops it is now almost never planted. It is an annual, but reseeds itself persistently. As it looks remarkably like oats or wheat until headed and has the same growing season as these it is necessary to rotate the grain fields when it gets established. Farmers long believed and many still believe that cheat can turn to wheat or oats and *vice versa*. It is very plentiful along borders on Glenn Burnie farm, and is a bad weed among the oat fields on Rocky Ridge Farm.

Rat's-tail Fescue Grass (*Festuca myuros*).

This is a delicate grass with round, thread-like leaves that makes up a large part of the roadside and embankment growth on Glenn Burnie Farm and in waste places generally. As it is an annual and dies early in summer it would not be of much use as a lawn grass except for Bermuda lawns, and there are others better for this purpose.

Red Top (*Agrostis alba*).

This is one of the principal forage and lawn grasses of the northern states and is undoubtedly an ingredient of all or nearly all the lawn mixtures we get from seedsmen. In this latitude, however, it is not able to maintain itself for many years in competition with other vegetation and while helping to fill in the lawn for two or three years, it does not last much longer. It is a spreading and procumbent grass that is easily recognized by its glaucous green color with a tint of purple in all parts. In Chapel Hill it can be detected in most recently sowed lawns, and in the arboretum it seems to be maintaining itself better than usual, due probably to the moist nature of the soil. In the paths here young seedlings of red

top and blue grass appear in abundance every spring. For low grounds in this section it is a valuable forage grass and persists much better than in uplands.

CREEPING BENT GRASS (*Agrostis stolonifera*).

This is probably only a variety of red top, but the two have a very different appearance here. It delights in damp shaded soil and makes a thick fine carpet in such places. It is frequently an ingredient of lawn mixtures, but is good only for a short time except in the wettest places. In Chapel Hill it has formed a fine and permanent turf on the northwest corner of the arboretum on the north side of the row of hydrangeas.

SHEEP FESCUE (*Festuca ovina*).

This is a very hardy perennial grass that is very useful for dry sandy and rocky soil where little else will grow, and as our southern lawns are usually subjected to rather rough treatment it is well to include it in the mixtures that we sow. On account of its tufted habit it is not ideal for lawns, but the tufts are not so coarse as those of orchard grass or sweet vernal grass and it is far more hardy than either. The leaves are slender and thread-like and vary much in color, from bright green to a much lighter glaucous green. If lawn mixtures containing sheep fescue are sown in poor dry soil the fescue will be about all that is left after the first summer. This can be well seen on the terraces by the Chemical building and Davie Hall as well as the mounds around trees near the Alumni Building. It was about the only perennial grass growing spontaneously in the poor gravelly soil at The Rocks before the place was fertilized and sowed with other grasses. It is of very little use as an agricultural grass in this section.

A more delicate variety of sheep fescue (*var. capillata*) is rather plentiful in spots in some of our lawns, e. g., the one east of Dr. Manning's on Rosemary Street.

RED FESCUE (*Festuca rubra*).

This is much like *F. ovina* in appearance, but grows somewhat larger and is less variable in color. It is not at all

common here, but may be seen in the Episcopal Church yard where it forms the deep green densely tufted cover on the south side by the rock wall, where shaded by cedar and elms.

CAREX TEXENSIS.

This little plant is not a grass but a sedge, and it is known in North Carolina only from Chapel Hill. It is the plant that forms the lawn over most of Mrs. Kluttz's yard on the west side, and it makes one of the best lawns in Chapel Hill, winter and summer, under the peculiar conditions there existing. The soil is unusually impervious and is much too wet in ordinary seasons for the best development of grass. The sedge finds this dampness congenial and has taken permanent possession. It is also an abundant constitutent of the deeply shaded lawn at the old Holmes Place (see Torreya *11*:11. 1911, for my first record of it from N. C.).

THE CLOVERS AND MEDICS.

There are two little creeping plants of this group that form a very conspicuous part of the winter and spring green of our lawns and waste places. They are low hop clover (*Trifolium procumbens*) and black medic (*Medicago lupulina*). They look so much alike that the casual observer makes no distinction between them, calling both hop clover, but the medic may be distinguished by its smaller and somewhat brighter yellow flower heads and, most easily, by the more elongated heads of *black, exposed, kidney-shaped pods.* The hop clover has, in fruit, nearly spherical heads, with the little brownish pods inclosed in the dried up persistent flower, giving them the appearance of a small head of hops. These two plants are winter annuals, coming in fall and dying out in May or June. They form the largest part of the spring green in the less shaded places of many of our lawns. White clover (*Trifolium repens*) is of course common in lawns, pastures and open places. It is frequently included in lawn mixtures with the grasses, and in such cases makes a larger part of the winter and spring green. It is a perennial, but unless well watered is apt to die out badly in summer.

CHAPEL HILL, N. C.

THE LAWN PROBLEM IN THE SOUTH

BY W. C. COKER

A perfect lawn as understood in our northern and middle states, Great Britain, and Europe generally, is a dense, homogeneous, evergreen carpet, composed of a single species of grass. Only in rare circumstances can such an ideal be fully attained, and it cannot be even approximated without good soil, water in dry periods, and constant care against the encroachment of weeds. As we are seriously handicapped by long, hot and dry summers, the ownership of a good lawn in the South will never be easy, and will always be the evidence of intelligence and care.

The factors that are necessary to the making of a good lawn are: (1) a rich and well drained soil; (2) the right grass or grasses; (3) water; (4) care (removal of weeds, frequent mowings, top dressings, etc.). As we usually neglect all of these essential factors, it is not hard to explain our failure.

To those who are willing to give their lawns the proper start and subsequent care, we suggest the following procedure: See that the soil is well-drained and all rocks, stumps, and trash are removed, and if the surface is irregular with ridges and sinks, a drag should be used to produce a perfectly level surface, or even slope. Give the area a heavy application of stable manure in the spring, at the rate of fifty two-horse wagon loads to the acre, and turn under deeply; put on a heavy application of water-slacked lime or of ground limestone, at the rate of about three tons to the acre, and harrow repeatedly with a cutaway harrow; continue this harrowing every two or three weeks during the summer About September 15th to the first of October add ground bone or cotton seed meal at the rate of 1,000 pounds to the acre, and harrow again, following the cutaway with a tooth harrow. After this give a finishing touch by raking by hand with a fine tooth rake. When this is done sow, at the rate of

100 pounds per acre, a mixture of equal parts of Kentucky blue grass, creeping bent grass, sheep fescue, and perennial rye grass, and cover with a compact cedar brush, or by raking again by hand. The rye grass will grow rapidly and will give a good effect the first winter before the other slower growing grasses make much show. The blue grass, if adapted to the situation, will grow stronger and denser each year, while the rye grass will pretty much all disappear after two or three years. The fescue and bent grasses are added in expectation that they will establish themselves in certain spots to which the blue grass is not adapted. Neither is so good for lawns as blue grass and where the conditions are just right for the latter the fescue and bent grasses may be omitted.

In early spring when the ground is not too wet run a roller over the lawn, and begin to use a mower as soon as the grass is high enough to cut. The rye grass will need cutting once or twice during the late fall. Look out for moles, and kill them. Water frequently during the first summer, and take out the weeds by hand. In October give another top dressing of cotton seed meal or bone meal. Look out for thin and poor spots, and sow more seed after scratching the surface with a rake, giving extra fertilization to these places. This will give the lawn a start. Its successful continuance will require an equal amount of attention and care.

In watering the lawn do not sprinkle lightly every day, but water thoroughly every four or five days. In large lawns it is a good plan to water a part every day, getting all over in four or five days. The amount of water necessary varies of course with soil, shade, and season, and must be determined by watching the grass.

The worst lawn weeds are the perennial ones, certain of which are constantly appearing even in the best kept lawns. They must be watched for, and kept out by hand. The worst through nearly all of our territory are lance-leaved plantain (*Plantago lanceolata*), smut grass (*Sporobolus indicus*), and the clovers. Locally, wild onions and nut grass are pestiferous.

The nut grass is almost ineradicable, and when it is thoroughly established one should proceed with the lawn exactly as if it were not present.

Onions, while very tenacious, can and should be removed. One way is to loosen up the bulbs with a long narrow mattock and lift each clump as it appears. It is also claimed that onions can be killed by squirting a half teaspoonful of crude carbolic acid down into the center of each clump with an oil can.

Dandelions are not the pest with us that they are in the north but they become somewhat troublesome near the northern limit of our range. They should be removed with the sharp corner of a hoe, as should also the plaintains and smut grass.

Bermuda grass as a weed is of such a nature as to warrant special remark. Bermuda is a sun-loving plant, and in shaded lawns will not cause much trouble. But in open sunny lawns in the South it is the exception when Bermuda does not enter and gain the mastery. In such a case the wise man will accept the decree of fate, and console himself with the thought that Bermuda will give a sod that for firmness, evenness, and duration cannot be surpassed in the South. Furthermore it has the exceedingly great advantage of not requiring water. It is moreover not difficult to superimpose a wintergreen lawn on the brown Bermuda by sowing in October a generous amount of perennial rye grass on the sod, adding at the same time a good application of bone meal or cotton-seed meal. The rains will beat the seeds down to a foothold, and their prompt growth will offset the approaching passage of the Bermuda to its winter brown. The rye grass, while a temporary perennial, will disappear in part during the following season, and should be sown again each fall. In open places under average conditions, we must accept this as the best solution of our lawn problem in the coastal plain region of the South. A Bermuda grass lawn is best started by sowing the chopped up runners in March.

A word finally to those who think that any kind of lawn

is too complicated or expensive an undertaking for them. If you can afford a lawn mower you will have the one thing needful to improve the appearance of your home 100 per cent. Simply get rid of the sprouts and big weeds and run the mower over whatever comes. The spontaneous summer grasses, even if mixed to some extent with weeds, will soon give you a pretty, green expanse that you will be proud of when you think of the disreputable patch of smut-grass and dog-fennel that you used to call your front yard. When you see this great improvement already made you will not be quite satisfied until you take down that old sagging fence and plant a hedge in its place. Then, as you grow in grace and in love of beauty, you will add shrubs to the corners and about the house, shape up the walks and keep them hoed, and screen the unsightly places with evergreen privets or mock orange (*Prunus carolinianus,* not osage orange, which is not evergreen). There will be joy in your heart at these transformations, and when, some day, you realize that the neighbors are trying to follow your example your full reward will appear.

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THE COLLECTION AND CULTIVATION OF CRUDE DRUG PLANTS IN NORTH CAROLINA, WITH SPECIAL REFERENCE TO THE CULTURE OF HYDRASTIS AND BELLADONNA

BY JOHN GROVER BEARD.

During the past decade there has been much agitation throughout the United States for drug cultivation. This agitation produced definite results soon after the outbreak of the European war, and has now crystallized into concrete efforts upon the part of large manufacturing houses to grow in this country as many medicinal plants as supply, demand, and feasibility would dictate. The original movement for drug cultivation was started by the United States Department of Agriculture, and was soon imitated by several of the state departments of agriculture, as well as by a few private individuals here and there. The world war has now brought home to us the fact that we were dependent upon Europe not only for toys, laces, lenses, and dyestuffs, but also for a large part of our medicinal supplies. Such crude drugs as scopola, hyoscyamus, belladonna, digitalis, and ergot could no longer be obtained from Europe, and the United States had to face the problem of supplying these drugs or doing without them. With characteristic ability the country has gradually added to the supply, and while it is hardly within even a reasonable distance of the demand, it is perhaps safe to assume that, conditions constantly improving, we will at no distant time be independent of the more important European drugs.

Unfortunately, however, North Carolina, to whom nature has bounteously furnished so many drug plants, has not yet awakened to her opportunities and is year by year allowing a potential source of much wealth to rot in her fields. With her coastal plains, sand-

hill region, and mountainous districts, the State possesses not only the variety of soils and altitudes necessary for the growth of these drugs, but also a favorable climate for many varieties of what have heretofore been considered strictly European and Asiatic plants. North Carolina conservatism, which shows itself hurtfully in many other ways, is robbing our rural people of a source of income which would materially assist them in making their farming more profitable. This state of affairs must not continue longer; the farmer and his family must be shown how to augment their finances by the collection and cultivation of medicinal plants. Boys' Corn Clubs and Girls' Tomato Clubs are excellent institutions and should, of course, be encouraged, but why ignore so valuable a source of revenue as crude drug collection and cultivation would soon prove itself to be? Why not organize Juvenile Herb Clubs throughout the State? Hundreds of wild drug plants—some recognized and some unknown; some rare but many numerous; a few almost valueless but by far the greater number worth a good price, lie close at hand. Why not realize profits from them?

In the distribution of medicinal plants over the State, we have distinctly marked districts, well characterized by their flora. The peculiar growth of one district may penetrate, overlie and underlie that of another, yet the predominating character of each be sufficiently marked and striking to arrest the attention of even a careless observer. The absence of the long-leafed pine (*Pinus australis*) marks the transition from the eastern to the middle botanical district, a rough boundary being the main line of the Atlantic Coast Line Railway from Weldon down through Fayetteville. The middle district reaches westward to the base of the Blue Ridge Mountains. The western or upper district extends from this point to the Tennessee line. It is in this latter district, perhaps, that North Carolina offers the collector the greatest variety and abundance of drug plants, although the eastern and central divisions are not poor in their supply. This mountain district is as peculiar and interesting in its plant products as it is attractive in its scenery. The ascent of every one hundred feet presents new and varying species until we reach the region of the dark and sombre firs, where we have a vegetation almost entirely northern. There is also a striking peculiarity in the vegetation of these higher regions which rarely fails to attract the eye of a visitor in the profusion of grace-

ful ferns and delicate mosses that cover the slopes. These, for the most part, are identical with species found in the mountains of the northern states, and many are common to similar situations in the Old Country; some, however, seem confined to our own mountains.

Wallace Brothers established a drug firm in Statesville a number of years ago for the purpose of buying, milling, and selling crude drugs. This firm advised country merchants that they would pay good prices for certain dried plants, and the merchants in turn told the country people that they could sell roots, herbs, etc., just as they could corn and wheat. Wallace Brothers are still in business in Statesville and have done a great work for the people of the State, especially the farmers of certain western counties. There are also several farms in the mountains devoted to raising drug plants. The more pretentious of these are the Sandidge Ginseng Gardens, at Bryson City, the Waynesville Ginseng Gardens, and Toms's Farm, at Hendersonville. A few years ago S. B. Penick & Co., of New York, established a branch of their crude drug firm at Marion and are engaged in the same line of work as Wallace Brothers, of Statesville. E. G, McGuire & Co., of Asheville, are also crude drug merchants.

In spite of these activities upon the part of crude drug growers and merchants, the industry is still in its infancy and in great need of stimulation. Some of the rural schools are teaching the recognition, collection, and proper curing of a few of the more important drug plants, and doubtless this subject will be given more attention in the schools, from now on, especially schools in the mountainous portions of the State.

The following drug plants have been obtained from this State. Many of them grow naturally, many more can be readily cultivated where the demand and market price is sufficient to justify the ventures. This list does not represent all the medicinal plants which have been found in North Carolina by any means, but perhaps covers the commoner ones. Many of them are collected and sold to "patent medicine" firms:

NATIVE AND CULTIVATED DRUG PLANTS OF NORTH CAROLINA

I. *Official.*—American or Green Hellebore (*Veratrum viride*), Blackberry Bark (*Rubus villosus,* etc.), Black Haw (*Viburnum prunifolium*), Black Snake Root (*Cimicifuga racemosa*), Blood

Root (*Sanguinaria canadensis*), Boneset, Thoroughwort (*Eupatorium perfoliatum*), Burdock Root (*Arctium Lappa*), Canadian Hemp (*Apocynum cannabinum*), Castor Oil Bean (*Ricinus communis*), Cotton Root Bark (*Gossypium herbaceum*), Cramp Bark (*Viburnum opulus*), Cranesbill (*Geranium maculatum*), Culver's Root (*Veronica virginica*), Dandelion (*Taraxacum officinale*), Fennel Seed (*Foeniculum vulgare*), Golden Seal, Yellow Puccoon (*Hydrastis canadensis*), Horehound (*Marrubium vulgare*), Hops (*Humulus lupulus*), Indian Tobacco (*Lobelia inflata*), Jimson Weed (*Datura Stramonium*), Lady's Slipper (*Cypripedium hirsutum*), Male Fern (*Dryopteris marginalis*), Lilly of the Valley (*Convallaria majalis*), Mandrake (*Podophyllum peltatum*), Pennyroyal (*Hedeoma Pulegioides*), Peppermint (*Mentha piperita*), Pink Root (*Spigelia marylandica*), Pipsissewa (*Chimaphila umbellata*), Poke Root (*Phytolacca decandra*), Prickly Ash (*Fagara Clava-Herculis*), Pumpkin Seed (*Cucurbita Pepo*), Queen's Root (*Stillingia sylvatica*), Sage (*Salvia officinalis*), Sassafras (*Sassafras variifolium*), Scarlet Sumac (*Rhus glabra*), Skullcap (*Scutellaria lateriflora*), Seneka Snake Root (*Polygala Senega*), Spearmint (*Mentha spicata*), Sweet Flag (*Acorus Calamus*), Vandal Root (*Valeriana officinalis*), Virginia Snake Root (*Aristolochia Serpentaria*), Wahoo (*Euonymus atropurpureus*), White Oak (*Quercus alba*), Wild Cherry (*Prunus serotina*), Witch Hazel (*Hamamelis virginiana*), Yellow Jasmine (*Gelsemium sempervirens*).

II. *Unofficial.*—American Sarsaparilla (*Aralia nudicaulis*), Angelica Root (*Angelica atropurpurea*), Balm of Gilead Buds (*Populus candicans*), Bayberry (*Myrica Cerifera*), Bear's Foot (*Polymnia uvedalia*), Birch Bark (*Betula lenta*), Black Willow (*Salix nigra*), Blue Cohosh (*Caulophyllum thalictroides*), Blue Flag (*Iris versicolor*), Catnip (*Nepeta cetaria*), Chestnut (*Castanea denatata*), Colic Root (*Dioscorea villosa*), Corn Silk (*Zea mays*), Crawley's Root (*Corallorrhiza odontorhiza*), Deer's Tongue (*Trilisa odoratissima*), Dogwood (*Cornus florida*), Elder (*Sambucus canadensis*), Eve's Cup Plant, Fringe Tree (*Chiananthus virginica*), Ginseng (*Panax quinquefolia*), Hydrangea (*Hydrangea arborescens*), Indian Physic (*Porteranthus trifoliatus*), Indian Turnip (*Arisaema triphyllum*), Jersey Tea (*Ceanothus americanus*), Larkspur (*Delphinium consolida*), Lemon Balm (*Melissa of-

ficinalis), Life Everlasting (*Gnaphalium obstusifolium*), Liverwort (*Hepatica Hepatica*), Mullein (*Verbascum thapsus*), Passion Flower (*Passiflora incarnata*), Pleurisy Root (*Asclepias tuberosa*), Sampson's Snake Root (*Psoralea melilotoides*), Skunk Cabbage (*Spathyema fœtida*), Solomon's Seal (*Polyganatum biflorum*), Sour Wood (*Oxydendrum arboreum*), Spikenard (*Aralia racemosa*), Squaw Vine (*Mitchella repens*), Star Grass (*Aletris farinosa*), Star Root (*Chamaelirium luteum*), Tansy (*Tanacetum vulgare*), Trailing Arbutus (*Epigea repens*), Tulip Tree (*Liriodendron tulipifera*), Turkey Corn, Corydalis (*Bikukulla canadensis*), Wafer Ash (*Ptelea trifoliata*), White Ash (*Fraxinus americanus*), Wild Ginger (*Asarum canadense*), Wild Indigo (*Baptisia tinctoria*), Wintergreen (*Gaultheria procumbens*), Wormseed (*Chenopodium anthelminticum*), Yellow Dock (*Rumex crispus*), Yellow Parilla (*Menispermum Canadense*), Yellow Root (*Xanthorhiza apiifolia*).

A few general remarks concerning the cultivation of drugs, and I shall then take up in detail two drugs which I consider well worth cultivating in this State.

While it is true that our forests are full of wild drug plants that are easily collected, it is not within the province of this paper to treat of this subject fully in view of the fact that identification methods would have to be gone into exhaustively. At a later date this phase of the subject will be presented.

The first essential for the grower to consider is the selection of a proper plot for growing the drugs. Naturally, different drugs require different soils and climates, as a result of which three or four plants should be selected for cultivation and the matter of their growth be given serious study.

In what I have to say about drug cultivation I will quote rather freely from a similar paper which appeared in the *Journal of the American Pharmaceutical Association* in January, 1914, entitled "The Cultivation of Medicinal Plants in America," by Henry Kraemer, of Philadelphia, one of the foremost authorities along this line in the United States.

Generally speaking, the cultivation is done by one of two methods: (1) plants grown from seeds, and (2) propagation by cuttings. Since the former plan is the simplest one for the beginner, I shall deal first with it.

PLANTS GROWN FROM SEEDS.

When plants are grown from seeds it is necessary to begin the germination of the seed early in the spring. This should be done either in the house or under conditions where there is some protection. The seeds may be sown in flower beds in which the soil is quite sandy, clean and free from organic matter which is likely to cause mold. The seed should not be planted too deep, and should be covered with glass so as to hold the moisture. The germination period varies considerably. If quick germination is desired, the simplest plan is to place the seeds in water for 24 hours; or, if a tough seed coat is being dealt with, germination may be hastened by pouring hot water upon them, or some special treatment may be given them, such as the use of dilute mineral acids. After the seedlings have a few leaves upon them they should be set out in suitable boxes known as "flats." These boxes should be about three inches deep and about two feet square, and the soil—which again should be sandy—should have added to it a certain amount of nutriment. Care must be taken to ward off the attacks of micro-organisms in the soil. Some special method is necessary for overcoming this. Dilute sulphuric acid has been utilized for this purpose by the Department of Agriculture. The seedlings are allowed to grow in the "flats" until they have developed a good root system and have three or four leaves. Before putting them directly in the soil out of doors, they may be hardened, if thought desirable, by placing them in cold frames. This transfer should be made not later than the early part of May. Practical gardeners are familiar with such frames. When the plants are transplanted out of doors it is very desirable that this be done as quickly as possible after the last frost. The plants are arranged in rows sufficiently far apart for "weeding" and working, so that the maximum crop per acre can be obtained. Such plants as belladonna, hydrastis, and ginseng are easily grown by this method.

PROPAGATION BY CUTTINGS

This is a common method of propagatng plants. A "cutting" is a severed portion of a stem, having one or more nodes or buds. They are derived either from above-ground shoots, as in geranium, or from the root stocks, as in the case of hydrastis. In the case of

both ginseng and hydrastis, one-year-old plants are frequently supplied by growers, and while, everything considered, this is not desirable, yet for experimental purposes this method may be employed.

COLLECTION AND DRYING

The season at which drug plants are collected varies with each particular plant. It is important for the grower to determine the proper season for collection, since the active matter contained therein is present in small quantities at certain seasons and in maximum amounts at others. For instance, experiments thus far seem to show that belladonna leaves collected in July and August show a higher alkaloidal per cent than those gathered in September or October. The United States Department of Agriculture will supply information as to the proper season for collecting the important drug plants.

Too much attention cannot be given to the proper methods of drying, especially with the root and fleshy fruit drugs. This must generally be done in a specially prepared room, which can be equipped at small cost.

RELATIVE VALUE OF DRUGS FROM CULTIVATED AND WILD PLANTS

It has long been questioned whether the activity of drugs derived from cultivated plants is equal to that of those derived from wild plants. Some foreign pharmacopœias require that the wild plant of digitalis and belladonna be used, the inference being that the wild are preferable to the cultivated. However, in 1907, Mr. Rippetoe's experimental work in Virginia showed that cultivated plants of belladonna yielded both leaves and roots which were equal, if not superior, to the average drug on the market. These results were published in the *American Journal of Pharmacy* for November, 1907. Carr (*Amer. Jour. Phar.,* December, 1913), has shown, also, that cultivated belladonna has a greater toxicity than the wild plant. Carr states that nitrogenous manures tend to lower the percentage of alkaloids, and Miller reports (*Amer. Jour. Phar.,* July, 1913) having grown belladonna plants with commercial acid phosphate and obtained a yield of alkaloids as high as 0.9 per cent. He has obtained similar results with wild and cultivated plants of stramonium. The experiments conducted in Summerville, S. C.,

by the United States Department of Agriculture have shown that in that locality *Cannabis indica* (Indian hemp), of a somewhat high degree of potency, can be cultivated. The development of the tea industry in South Carolina is one of the most creditable pieces of work of the National Government. Bulletitn No. 234 of the Bureau of Plant Industry, on the "Cultivation and Manufacture of Tea in the United States," should serve as an inspiration to anyone contemplating drug culture. If a plant of this kind can be grown successfully here and the technique of manufacture developed to such an extent that the cultivation in South Carolina has become remunerative, there is no reason why the majority of the drug plants—except the strictly tropical ones—cannot be successfully grown in the United States, and 75 per cent of these in North Carolina. Experience has shown that cultivated crops command a higher price than the drugs obtained from wild plants, even though their superiority cannot always be demonstrated by analytical means. The improvement of a plant from the standpoint of the active matter which it contains may be effected by continually selecting for propagation such plants as conform most closely to the ideal sought, by the selection of spontaneous variations or sports, and by hybridization. Breeding, or cultivation, has been slow because of ignorance upon the part of the grower, upon the quality of drug plants sought, and, also, because not many people possess knowledge of what drugs are required or what kind of soil and climate is best adapted to the different species.

The time allowed for the presentation of this paper permits a discussion of the cultivation of only two important drugs, Hydrastis and Belladonna.

HYDRASTIS.

(Synonyms: Golden Seal, Yellow Puccoon, Indian Dye or Turmaric, Jaundice Root, and Orange Root.)

Golden Seal, so called by reason of the yellow seal-like scars on the fleshy rhizomes, was once abundant in wooded portions of Ohio, Indiana, Kentucky, and West Virginia, and, to a less extent, was found in the western part of this State. Its natural location is in rich, open woods where leaf mold is abundant. The drug was discovered in 1793 and was made official in the United State Pharmacopœia of 1860. Its original cost was 10 cents a pound; it now

costs about $5 a pound and yields the grower from $3 to $4. It is easily cultivated and thrives best in rich, soft, loamy woodlands, and should at all times be kept free from grass. If a wooded tract is not available, artificial shading should be supplied. Hydrastis lives from four to six years, the rhizomes becoming weaker with age. The propagation should be by cuttings. The matured rhizomes contain many rootlets and undeveloped buds. Just as each "eye" in a potato will produce a new plant, so will each bud on the rhizome provide a young shoot, if only the root be left with it. In propagating the plant, the rhizomes should be sliced transversely into several parts, each having its bud and a few of the fibrous roots, and these should be planted a few inches apart, in rows, in shaded, grass-free beds containing suitable moist soil. The young plants will show a quick, thrifty growth. Many cuttings which apparently die, spend their first year in budding up a good root and bud system, and the second season will bring forth vigorous young plants. The rapid rate at which an hydrastis bed may be increased by means of cuttings is indicated by the fact that one old root will yield about five eye-cuttings, each with rootlets. The cuttings should be planted about one inch beneath the soil, a few inches apart, and allowed to remain for two years and then transplanted into rows or a bed. The parent rhizome (four to six years old), after the leaf has withered but can still be located, should be lifted from the earth and three-fourths of it cut off, the growing end bearing the terminal bud replaced in the earth, thus leaving in the bed the full-grown plant to continue the life of the bed. Hydrastis rapidly depletes the soil, which should be replenished either by well-mulched horse manure, henyard refuse, wood ashes, butcher-shop waste, or barn manure, worked into an artificial soil. Wild soil should not be added because of the contamination of insects and other pests, such as worms, snails, etc. The plants should be occasionally sprayed with Bordeaux mixture.

ATROPA BELLADONNA

(Synonyms: Deadly Nightshade, Black Cherry,. Great Morel, etc.)

The United States Pharmacopœia recognizes the leaves and roots of this plant and specifies that the leaves shall assay not less than

0.35 per cent and the roots not less than 0.45 per cent of mydriatic alkaloids such as atropine, belladonine, hyoscyamine, and hyoscine.

Belladonna is an old drug which was known to the ancients. It derives its name from two Italian words, "bella," beautiful, and "donna," lady, *i. e.*, the berries were used by Italian ladies as a cosmetic., and to dilate the pupils of the eyes, thus rendering them more beautiful and handsome.

Belladonna is a bushy, strong-growing, perennial herbaceous plant, with a fleshy creeping root from which arises several erect, round, purplish branching stems to the height of about three feet. There have been many efforts put forth during the past ten or fifteen years to grow the plant upon a commercial scale in this country, but up to the present time but few growers have been successful from a financial standpoint. The cost of production has equaled or exceeded the selling price. The development of the industry consequently has been slow, in many cases expensive, and at times so discouraging as to almost cause its complete failure and subsequent abandonment. However, the European war has practically cut us off from our former supply and prices, as a result, have reached such figures as to promise a great stimulus to former cultural efforts, and should go far toward seeing belladonna put upon a paying basis as a cultivated drug in the United States. The Bureau of Plant Industry of the United States Department of Agriculture has furnished growers with the experience gained from exhaustive cultural experiments, and, in addition, such firms as Sharp & Dohme and Parke Davis & Co., have given to the public the results of their efforts to cultivate this valuable drug. With these facts, suggestions, and cautions against previous mistakes, vigorous efforts will undoubtedly be made by growers to furnish pharmacy with a supply of the home-grown drug.

A discouraging feature of belladonna cultivation is the long period of time required for the seeds to germinate, four to six weeks being a minimum time even under greenhouse conditions. The plant requires rich, moist, calcareous soil with ample atmospheric moisture. The temperature should never go below 10° F. in a region where belladonna is to be grown unless the tedious process of hardening the young plants is resorted to before they are transplanted to the open fields. In North Carolina, where such a

low temperature never prevails during the growing season, the seeds may be germinated in large, shallow boxes, provided with glass covers to conserve the moisture, and the young plants may be transplanted to the desired plot, spacing the plants three by three feet. With this spacing, approximately forty-seven hundred plants can be set out to the acre. Subsequent cultivation for belladonna may be about the same as for corn until the plants begin to branch, when some form of a single plow must be adopted. In the meantime the crop must be protected from insects and plant diseases. The common potato beetle is the insect which must be constantly fought, and curbing efforts should be resorted to during the earliest stages of growth. If arsenical solutions are employed at this early period, the leaves which have been sprayed will drop off before maturity, and this eliminates danger of arsenic being present in the leaves and roots when they are collected for the market. Plant lice can be eliminated by tobacco sprays, which are harmless. The young plants should be watered frequently.

According to Rippetoe the leaves should be collected in July or August to insure the greatest alkaloidal yield, for after that the contents begin to decrease. Whether the alkaloids are lost during the later plant processes or are returned to the root is a question. The latter inference has much weight with many authorities. In fact it is generally advised that the leaves should be pulled in July or August of the second year, and the roots in the fall of the fourth years' growth, the seeds for future propagation being of course gathered in the fruiting season.

Belladonna is now (January, 1916) bringing $2.00 per pound. Since there is no apparent relief in sight from the present belladonna famine, and because of the fact that this is a much-needed drug plant, it is urged that cultural methods be begun in this State.

A fact upon which emphasis should be laid is that heretofore the drug has been cultivated in the northern states where the climate is somewhat too rigorous. In North Carolina it would doubtless be profitable to raise the drug, since we have a temperate climate, the kind of soil necessary, a six or seven months growing season, and only an insignificant fall weed crop.

The following plants could probably be cultivated successfully in North Carolina, though there is not sufficient evidence to justify a positive statement.

Arnica montana. Abundantly used, easily grown in almost any soil, but cost of labor might prevent profit.

Capsicum fastigiatum. Has a limitless demand as native sources have about become depleted. Bears continuously in Florida; should be successfully cultivated here.

Cascara Sagrada (Rhamnus Purshiana). Grows well around Washington, D. C., and would doubtless thrive in the sandy soil of southern North Carolina. Amount of the bark used is almost incredible and native supplies are almost exhausted; hence it must ultimately be cultivated. Seeds can be readily obtained. It will grow well in any soil.

Cannabis indica (Hashish, etc.). At present the Pharmacopœia requires that the East Indian variety be employed, but likely the forthcoming issue will allow the naturalized form (*Cannabis sativa*), which has been proved to be even more active. Should this permission be granted the drug could be easily and profitably raised here.

Colchicum officinale. Very largely used, seed and corn being official; easily grown; price is rather low. Requires a rich, light soil.

Conium maculatum. The fruit is used and is valuable in medicine. It is grown in the field like wheat or rye, and harvested in a similar manner. Its culture in this country has probably never been attempted, but since other species of this genus grow wild in our fields there is reason to suppose the *maculatum* would also grow here. The drug as at present obtained is liable to adulteration, and a clean, pure supply would be eagerly received.

Digitalis purpurea. Largely used, fair prices paid. Plant seed in drills and transplant to fields when well established; set in rows two feet apart and plants separated by eighteen inches. Gather leaves during commencement of blooming period and dry carefully in shade.

Claviceps purpurea (Ergot). A parasitic fungus, replacing the grain of rye, a pound being worth as much as two bushels of rye. It has never been practically established in this country as yet, but is well worth experimenting with.

Rhamnus Frangula (Frangula, Buckthorn). Can be easily grown in swamp lands, replacing ordinary brook-alder. Is abundant

and cheap, but often adulterated, and manufacturers would be glad to get their supply from cultivators who could insure purity.

Artemisia pauciflora (Santonica). Greatest difficulty would be collecting seed from a reliable source, as the present supply comes from Turkey, but the experiment is well worth trying. A brand known to be pure would bring a high price, as santonica is largely used for the extraction of santonin, and for two years the genuine has been scarce and expensive.

Pimpinella Anisum. Will not grow as far north as New York, but could perhaps be grown in this State.

This list does not include the indigenous North Carolina plants, as it goes without saying that their cultivation would be relatively easy. The Government publications listed below will be of much help to the prospective drug cultivator.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE ON DRUG PLANTS, ETC.

PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

Weeds Used in Medicine. By Alice Henkel. Pp. 45, figs. 31. 1904. (Farmers' Bulletin 188.)

Growing and Curing Hops. By W. W. Stockberger. Pp. 39, figs. 20. 1907. (Farmers' Bulletin 304.)

Harmfulness of Headache Mixtures. By L. F. Kebler, F. P. Morgan, and Philip Rupp. Pp. 16. 1909. (Farmers' Bulletin 377.)

Habit-Forming Agents: Their Indiscriminate Sale and Use a Menace to the Public Welfare. By L. F. Kebler. Pp. 19, figs. 5. 1910. (Farmers' Bulletin 393.)

The Cultivation of American Ginseng. By Walter Van Fleet. Pp. 14, figs. 3. 1913. (Farmers' Bulletin 551.)

Golden Seal Under Cultivation. By Walter Van Fleet. Pp. 15, figs. 5. 1914. (Farmers' Bulletin 613.)

The Source of the Drug Dioscorea, with a Consideration of the Dioscoreæ Found in the United States. By Harley Harris Bartlett. Pp. 29, figs. 8, 1910. (Bulletin 189, Bureau of Plant Industry.)

Some Effects of Refrigeration on Sulphured and Unsulphured Hops. By W. W. Stockberger and Frank Rabak. Pp. 21. 1912. (Bulletin 271, Bureau of Plant Industry.)

PUBLICATIONS FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

The Adulteration of Drugs. By Lyman F. Kebler. Pp. 251-258. 1904. (Separate 331, from Year Book of the Department of Agriculture, 1903.) Price, 5 cents.

Peppermint. By Alice Henkel. Part 3, pp. 19-29, figs. 3. 1905. (From Bulletin 90, Bureau of Plant Industry.) Price, 5 cents.

Wild Medicinal Plants of the United States. By Alice Henkel. Pp. 76. 1906. (Bulletin 89, Bureau of Plant Industry.) Price 5 cents.

American Root Drugs. By Alice Henkel. Pp. 80, figs. 25, pls. 7. 1907. (Bulletin 107, Bureau of Plant Industry.) Price, 15 cents.

The Sources of Arsenic in Certain Samples of Dried Hops. By W. W. Stockberger. Part 4, pp. 41-46. 1908. (From Bulletin 121, Bureau of Plant Industry.) Price, 5 cents.

American Medicinal Barks. By Alice Henkel. Pp. 59, figs. 45. 1909. (Bulletin 139, Bureau of Plant Industry.) Price, 15 cents.

American Medicinal Leaves and Herbs. By Alice Henkel. Pp. 56, figs. 36. 1911. (Bulletin 219, Bureau of Plant Industry.) Price, 15 cents.

The Diseases of Ginseng and Their Control. By H. H. Whetzel and J. Rosenbaum. Pp. 44, figs. 5, pls. 12. 1912. (Bulletin 250, Bureau of Plant Industry.) Price 15 cents.

American Medicinal Flowers, Fruits and Seeds. By Alice Henkel. Pp. 16, figs. 12. 1913. (Bulletin 26, U. S. Department of Agriculture.) Price, 5 cents.

Wild Volatile-Oil Plants and Their Economic Importance. I.—Black Sage; II.—Wild Sage; III.—Swamp Bay. By Frank Rabak. Pp. 37, figs. 6. 1912. (Bulletin 235, Bureau of Plant Industry.) Price, 5 cents.

CHAPEL HILL, N. C.

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